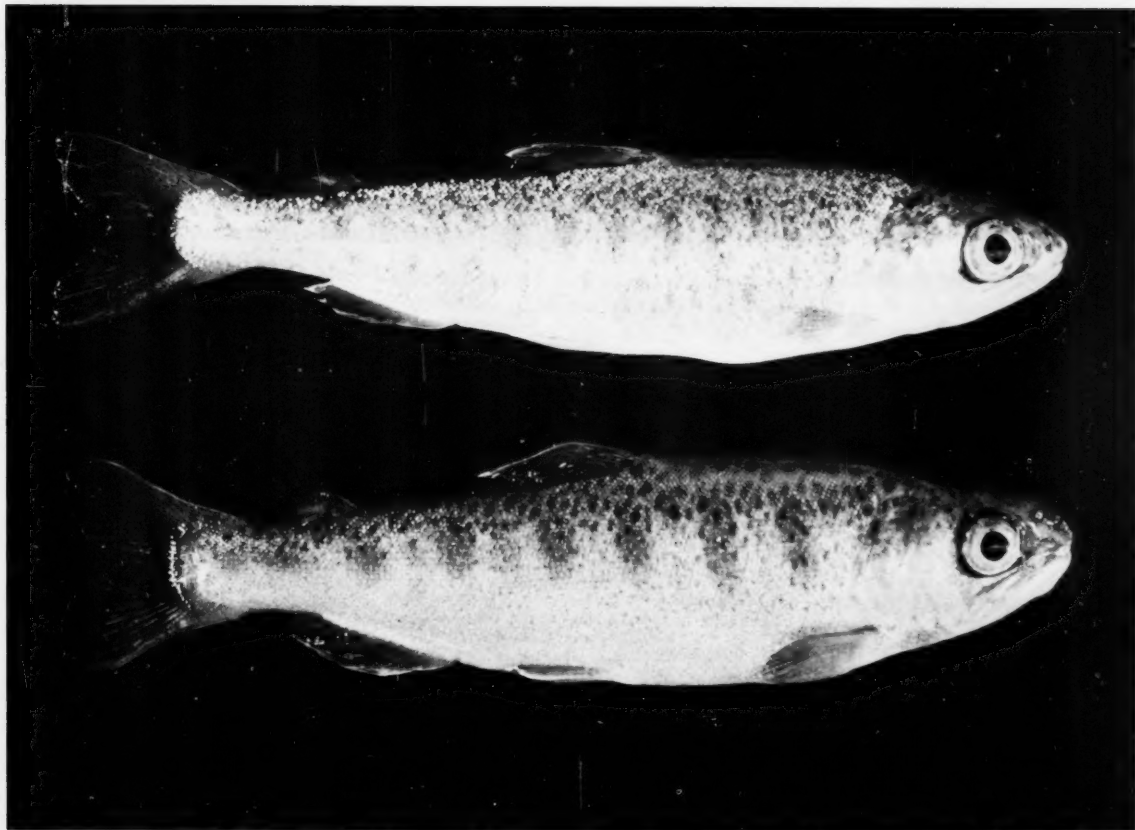




# Marine Fisheries REVIEW

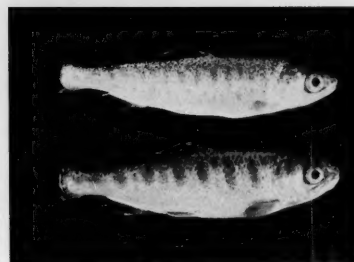
November 1982  
Vol. 44, No. 11

National Oceanic and Atmospheric Administration • National Marine Fisheries Service



**Timing Coho Releases**

# Marine Fisheries REVIEW



On the cover: A coho salmon smolt (above) and parr (below) at normal size at release. See the article beginning on page 11.

## Articles

November 1982, 44(11)

Frozen Seafoods: The Economic Feasibility of Quality Assurance to the Consumer

Carmine Gorga, Burton L. Tinker, Debra Dyer, and Joseph M. Mendelsohn 1

Adult Coho Salmon Recoveries and Their  $\text{Na}^+ - \text{K}^+$  ATPase Activity at Release

Roy J. Wahle and Waldo S. Zaugg 11

Chemical Composition and Frozen Storage Stability of Spot, *Leiostomus xanthurus*

Melvin E. Waters 14

## Departments

NOAA/NMFS Developments

Regional Fishery Management Council Members Named, Global Acid Rain Found, Chesapeake Bay Stripers Gain, Volcanic Dust Hits SST Data, and Marianas Cruise Locates New Bank 23

Foreign Fishery Developments

Italian Fishery Development, Mexico's PPM Expands Fleet and Production, Latin American Fishery Officials, Mexico's Shrimp Fleet to Coops, India Develops Fisheries, and Japan Sees Big Chum Catch 26

Publications

NWAFRC Technical Memoranda, International Fishery Organizations, Tuna Processing Handbook, International Shrimp Workshop, A Southwest Atlantic Ocean Zooplankton Atlas, and Two Uruguayan Fisheries Reports 30

## U.S. DEPARTMENT OF COMMERCE

Malcolm Baldrige, Secretary

## NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

John V. Byrne, Administrator  
William G. Gordon, Assistant  
Administrator for Fisheries

National Marine Fisheries Service

Editor: W. Hobart

*Marine Fisheries Review* (USPS 090-080) is published monthly by the Scientific Publications Office, National Marine Fisheries Service, NOAA, 7600 Sand Point Way N.E., Bin C15700 Seattle, WA 98115.

Single copies and annual subscriptions are sold by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. Prices are: Single copy, \$3.25 domestic, \$4.10 foreign; annual subscription, \$18.00 domestic, \$22.50 foreign. Copies of individual articles, in limited numbers are available from D822, User Services Branch, Environmental Science Information Center, NOAA, Rockville, MD 20852. News items are not reprinted.

Publication of material from sources outside the NMFS is not an endorsement and the NMFS is not responsible for the accuracy of facts, views, or opinions of these sources.

The Secretary of Commerce has determined

that the publication of this periodical is necessary for the transaction of public business required by law of this Department. Use of the funds for printing this periodical has been approved by the Director of the Office of Management and Budget through 30 June 1983.

The NMFS does not approve, recommend or endorse any proprietary product or proprietary material mentioned in this publication. No reference shall be made to NMFS, or to this publication furnished by NMFS, in any advertising or sales promotion which would indicate or imply that NMFS approves, recommends, or endorses any proprietary product or proprietary material mentioned herein, or which has as its purpose an intent to cause directly or indirectly the advertised product to be used or purchased because of this NMFS publication. Second class postage paid at Finance Department, USPS, Washington, DC 20260.

# Frozen Seafoods: The Economic Feasibility of Quality Assurance to the Consumer

CARMINE GORGA, BURTON L. TINKER,  
DEBRA DYER and JOSEPH M. MENDELSON

## Background

The most persistent and most unsalable critic of the quality of seafoods available to the U.S. public has been the Consumers Union, which publishes a widely read and respected magazine, *Consumer Reports*. In the 1960's and 1970's this magazine provided data from the publisher's objective surveys condemning the quality of seafoods nationwide (Anonymous, 1961). These surveys were corroborated by others, notably the surveys carried out by the Northeast Fisheries Center (NEFC) Gloucester Laboratory of the National Marine Fisheries Service<sup>1</sup> (NMFS) during 1963 and 1964.

It is important to note that none of these surveys placed any blame on specific segments of the U.S. seafood industry, not only because many of the products sampled were produced from imported fish, but especially because the domestic industry offered a most varied and complex picture.

Yet, even though the U.S. seafood industry had to be considered largely blameless, the problems associated with the industry were seemingly insoluble and they clearly had adverse economic and social implications for the country. Outstanding among these problems were: 1) The unfavorable image of fish as food; 2) the relatively

stagnant per capita consumption of seafoods; and, 3) the inability of the industry to supply the domestic market, much less to compete with foreign seafood industries in international markets, resulting in an increasing seafood trade deficit that is currently overshadowed only by those of oil and automobiles (Gorga and Ronsivalli, 1981).

In the early 1970's, an integration of relevant economic and technological data led the Gloucester Laboratory to the conclusion that these problems stemmed from a lack of consistently high quality. Therefore, the following simplifying hypothesis was formulated: "If consistently high quality could be assured to the consumer, the consumption of seafoods would increase and many problems of the industry would be abated."

To test the validity of this hypothesis, multifaceted efforts were undertaken to apply much of the known technology and thus improve the ability of the industry to assure quality. These efforts encountered a resistance rooted in such understandable preoccupations as: 1) "It would cost too

much to assure quality"; 2) "a program of quality assurance has been tried many times but always failed"; 3) fish prices are too high already"; 4) "people do not know how to prepare fish"; 5) fish smell up the house and utensils"; 6) "only a small number of people eat fish anyway"; etc.

The Gloucester Laboratory therefore found it necessary to design and to implement a strategy to convince the U.S. seafood industry that it pays to assure the quality of its products to the consumer, and to convince the nation that it pays to have a competitive U.S. seafood industry. The keystone of this strategy was the realization that to assure quality would take an integrated effort, combining the technical and leadership skills of the Gloucester Laboratory with the practical knowledge and facilities of cooperative seafood processors and seafood retailers. Thus, the first experiment concerning the assurance of the quality of fresh fillets to the consumer was organized and carried out. A brief review of this experiment helps to explain the current experiment concerning frozen fillets.

## Quality Assurance of Fresh Fish Fillets

An internal proposal<sup>2</sup> by the Gloucester Laboratory described a

<sup>1</sup>Tenney, R. D., J. P. Lane, J. Carver, and M. Steinberg. 1965. Internal report — survey on quality of retail frozen fillets. Bur. Commer. Fish., Technol. Lab., Gloucester, Mass.

Carmine Gorga is an associate of Joseph W. Slavin and Associates, 87 Middle Street, Gloucester, MA 01930, and Burton L. Tinker is Program Leader, Debra Dyer is Junior Scientist, and Joseph M. Mendelson is Senior Scientist at the Gloucester Laboratory, Northeast Fisheries Center, National Marine Fisheries Service, NOAA, Emerson Avenue, Gloucester, MA 01930. Mention of trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

<sup>2</sup>Ronsivalli, L. J. 1974. A study to determine the effect of assured quality of fish on its sales volume. An internal proposal. Natl. Mar. Fish. Serv., Gloucester Lab., Gloucester, MA 01930-2599.

comprehensive scheme, from point of catch to point of sale, that would deliver to the consumer seafoods of no less than U.S. Grade A quality. The highest quality was targeted because of the established image of poor seafood quality; and, obviously, because it would take the delivery of consistently high-quality seafoods if the consumer were to begin to view fish as other than "fishy."

The project got underway in 1974. Without the inclusion of fishermen, whose involvement—although not essential—was vigorously attempted without success, the quality control and inspection activities that are required to assure quality started at the point of landing rather than at sea. From that point on, the experiment was able to control quality up to the point of sale. This strict quality control regimen, also described in Ronsivalli et al. (1978) and Ronsivalli (1981), involved only two supermarkets at a time, but a total of six supermarkets participated during the 2 years of the project's operation. At the end of the project, an economic analysis was made, and when the findings were extrapolated to an activity involving a production rate of 10,000 pounds of fish fillets/day, an efficient production rate, the analysis showed that the unit cost to assure quality was \$0.10 per pound (Gorga et al., 1979). The analysis also showed that even this added cost was nullified because quality assurance helped eliminate losses due to spoilage and to markdowns. Thus, the analysis showed that it required no added cost to assure quality.

Ultimately, in that experiment, it was proved that it was economically feasible to produce and distribute products of consistently high quality, because customers were willing to pay up to \$0.50 per pound more for guaranteed quality fillets than for fillets whose quality was not guaranteed by the U.S. Grade A shield and by the implicit pledge of the retailer to withdraw from sale those products which were about to fall below the U.S. Grade A standard of quality.

Thus, the fears that it would cost too much to assure the quality of sea-

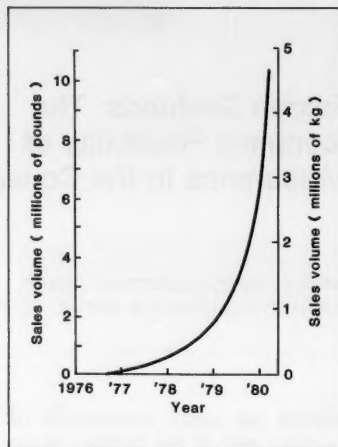


Figure 1.—Growth rates of sales of fresh fish fillets carrying the U.S. Grade A shield.

foods, that customers would not pay a higher price for quality assurance, and that quality assurance could not be attained were all found to be without basis. Supermarket operators were impressed not only with the suggested practice of prepackaging the fillets at the processor level, but especially with the elimination of consumer complaints. As expected, consumer satisfaction was reflected in significant increases in seafood sales during and especially after the experiment—when the duplication of the experimental design began to spread due to the obvious economic advantages of quality assurance for processors, retailers, and consumers.

The sum total of these projects exposed the existence of a burgeoning demand for high quality seafoods that has created a full-scale revolution in seafood marketing (Anonymous, 1981).

#### Verification of the Hypothesis and Basis for Further Experiments

After nearly a decade of efforts in quality assurance, the Gloucester Laboratory analyzed the industry's

progress to arrive at some measure of the validity of the original hypothesis that lack of quality in seafoods is the principal deterrent to consumption. Findings (Ronsivalli et al., 1981) exceeded expectations.

Figure 1 shows the growth of (presumably additional) sales due to the program of quality assurance. Even though the program was running with little or no assistance from the Gloucester Laboratory by this time, its growth maintained an exponential trend. Within 4 years, the sales volume had reached 11,000,000 pounds per year with a value of about \$30,000,000 per year. The number of stores had increased to more than 1,100, the number of processors had increased to more than 10, and the market area had expanded to include the 15 northeastern states.

One does not yet see these figures reflected in an increase in per capita consumption of seafoods in the United States, not only because the quantity of high quality or U.S. Grade A fresh fish measured against the entire seafood market is still comparatively small, but especially because in recent years there has been a decrease in the sale of frozen fishery products (Anonymous, 1981) and even a decline in the number of pounds of edible, mostly frozen, fishery products imported from abroad (USDOC, 1981).

Beyond these quantitative measurements, perhaps the best evidence of the significance of quality assurance of seafoods, whether in terms of its effect on the seafood industry or in terms of its benefits to the consumer and to the nation, is the existence of a large number of proposals and commitments to improve the quality of seafoods both in the United States and abroad (Gorga and Ronsivalli, 1981).

The ultimate reason for these efforts can be found in the existence of a difficult to measure, but evidently high latent demand for quality seafoods. As can be seen from the slope of the curve in Figure 1, which in 1980 was at its highest value, consumer demand for U.S. Grade A fresh fish fillets had not even begun to be satisfied—otherwise the curve would have started to "flat-

ten out." On the other hand, there were indications that the supply of U.S. Grade A quality fish fillets might not be able to satisfy a much higher demand (Ronsivalli et al., 1978).

It was this interplay between demand and supply that led the Gloucester Laboratory to consider whether the assurance of quality could not be extended to cover the production and distribution of frozen fish. The aim was to lay the groundwork for an eventual integration of the two programs: All fish that can be sold as U.S. Grade A fresh fish should be so sold; the rest should be sold as U.S. Grade A frozen fish. Thus we reach the core of the rationale for the study under consideration in this report.

### **The Rationale for Quality Assurance of Frozen Fish Fillets**

Although mainly imported, frozen fish fillets compose the bulk of the fillet supply in the United States. It has therefore been hypothesized that a successful effort to assure the quality of domestic frozen fillets should result in even higher benefits to the industry and the consumer than those experienced in the program of quality assurance of fresh fish fillets (Nickerson and Ronsivalli, 1979).

Specifically, the hypothesis is that quality assurance is the key factor in conquering the core of the problem associated with the production of frozen fish fillets in the United States. This is a three-part socioeconomic problem that can be described as follows: 1) U.S. consumers are generally of the opinion that frozen fish fillets can never be of as high a quality as fresh fish fillets. This widespread opinion is reflected in, and supported by, the fact that the prices for fresh fillets are generally higher than those for their frozen counterparts; 2) it costs more to produce frozen fish fillets than to produce fresh fish fillets; and finally, 3) because of this economic discrepancy, a producer or handler of fillets might be motivated to freeze the product only when it appears that the probability of selling it as fresh is dangerously low or at a time when the fillets

are at or near incipient spoilage—a practice which normally does not result in acceptable frozen products, and which propagates the first part of the problem.

A study was conducted in 1981 to test the validity of the hypothesis that quality assurance is capable of resolving this complex problem. The following sections report on the economic aspects of this experiment and attempt to determine whether it is indeed economically feasible to assure the quality of frozen fish fillets to the consumer.

## **Experimental Design and Procedures**

### **Sample Design**

An informal search among seafood processors led to the selection of Aslanis Fisheries of Boston, Mass., as the producer participating in the study. Even though this enterprise did not directly fillet most of the fish, it met all other basic criteria operating in the search: 1) Financial, technical, and organizational capability for producing U.S. Grade A frozen seafoods; 2) willingness to have its plant under continuous USDOC inspection; and 3) willingness to participate in the study.

At the same time that arrangements were made with the processor, it was also decided to select nine retail stores to follow the product all the way to the point of sale. Three stores were to serve as test stores; three as control stores; and three stores were to be used for special studies (e.g., the effect of price variations upon sales or the impact of an experimental display case upon cost savings and sales).

The retail chain, which was selected with full cooperation and assistance by the processor, did in fact provide nine stores, here identified as Store No. 1-9, and data were collected from these stores during the first 3 weeks of the experiment. However, since the chain became enthusiastic about the product and introduced it in all of its stores from the outset, a change in the experimental design became unavoidable. The intent to keep three stores as control stores and three stores for special studies was rendered nonoperational.

Then, not only was the number of test stores enlarged to five, but there was also a shift in the composition of the stores: Four stores, No. 2, 4, 5, and 6, remained in the sample and a new one was added to it, Store No. 10. The other stores were withdrawn from the study.

### **Store Location**

As pointed out earlier, the cost of producing frozen fish is higher than that of fresh fish, while retail prices tend to be lower for frozen fish. Therefore, an attempt was made to select stores away from the coast because, on the coast, such an economic dysfunction is more likely to be felt. This selection was also dictated by the presumption that sales of frozen fish are higher inland than along the coast.

After trying to select a supermarket chain in the Detroit, Mich., area, final selection of sample stores settled upon the next best alternative: A chain (Price Chopper) in the Albany/Schenectady area of New York.

Of especial socioeconomic interest is the fact that the five stores that participated in the test for the longest period of time are located along an axis that starts at the center of Albany and ends at the periphery of Schenectady. Figure 2 presents a schematic representation of this geographic arrangement. This disposition is interesting because it is an approximate representation of various socioeconomic strata of store customers, from low, to middle, and to upper income.

### **Data Collection**

In this study, unlike the previous one on fresh fish, control over all phases of the operation was retained by private industry. Consequently, responsibility for the collection of relevant data—with the exception of spot checks for temperature—was also assumed by private industry.

Thus, data on production volumes and costs for cod, haddock, pollock, and ocean perch were collected by the processor for January to June 1981. Data for retail sales and consumer prices were collected by the supermarket chain for frozen Grade A,

Table 1.—Production volume, by month, in pounds.

Species	January	February	March	April	May	June	Total
Cod	6,780	11,073	0	2,960	3,890	1,492	26,195
Haddock	8,570	14,681	0	0	5,945	0	29,196
Pollock	2,000	1,852	2,000	4,100	3,500	0	13,452
Ocean perch	3,200	2,680	1,840	2,060	0	4,829	14,789
Total	20,550	30,466	3,840	9,120	13,335	6,321	83,632

Table 2.—Processor sales, by month, in pounds.

Species	January	February	March	April	May	June	Total
Cod	5,200	3,000	2,900	320	1,000	300	12,720
Haddock	7,600	1,510	2,780	280	2,020	380	14,570
Pollock	1,800	2,020	1,560	40	1,000	0	6,420
Ocean perch	3,000	2,120	2,560	100	1,000	0	8,780
Total	17,600	8,650	9,800	740	5,020	680	42,490

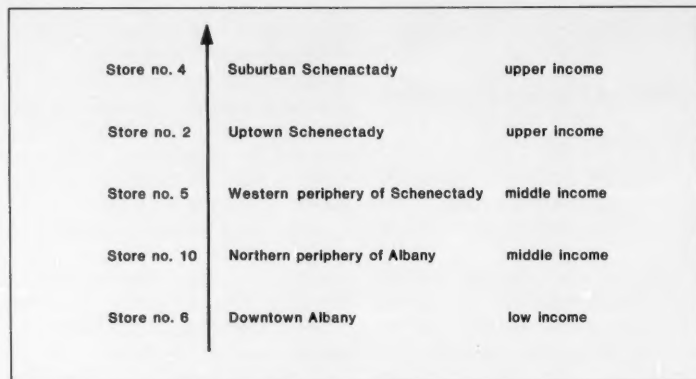


Figure 2.—Schematic representation of geographic location of test stores and income status of customers. The geographical axis runs from southeast to northwest.

Table 3.—Unit production costs per pound.

Item	Cost	Item	Cost
Raw material	\$1.460 <sup>1</sup>	Direct labor	\$0.023 <sup>2</sup>
Film—top	0.039	3 Vac. pac machines	0.013 <sup>3</sup>
Film—bottom	0.052	Inspection	0.013 <sup>4</sup>
Carton	0.018	Miscellaneous	0.100 <sup>5</sup>
Label	0.011	Overhead	
Recipe label	0.006		
Tape	0.001	Total	\$1.74

<sup>1</sup>Weighted average price per pound for the four species mentioned in the text. (Price per pound × pounds per species ÷ total pounds.)

<sup>2</sup>23 workers at \$4.32/hour, producing 4,305 pounds/hour, or 4,920 packs at 14 ounces average per pack.

<sup>3</sup>Value of machines: \$161,465 amortized over 5 years, interest not included, and producing an average of 10,000 pounds for 250 days per year, an efficient production rate.

<sup>4</sup>\$32.60 hours × 4 hours ÷ 10,000 pounds. Actual inspection cost as an average of 6 months activity was \$0.045.

<sup>5</sup>Includes freezing costs and especially the high cost of keeping working rooms temperature at 40°F as well as the related cost of high labor turnover due to uncomfortable working conditions. No better estimate of these costs can be reached because it is difficult to separate the production volume covered by this study from the total production volume of the firm.

frozen ungraded, and fresh fish fillets from February to May 1981.

In addition to the four species for which data were collected at the processor level, at the retail level data concerning sales and prices were collected for flounder as well. These data were collected in test stores for 1-14 nonconsecutive weeks, for a total of 16 weeks. Data for total meat department sales including meat and fish, and percentages for various items of this total were also collected for about 2 years starting with the week of 21 October 1979, more than 1 year before the beginning of this study. At the processor level data were collected monthly, while retail data were collected weekly.

### Results and Discussion

We will first analyze the findings

concerning the operation of the processor, and then that of the retailer. We will join the two sets of issues in the last two sections, Conclusions and Recommendations.

### Production Volume

During 6 months of the study, the processor purchased and processed 83,632 pounds of cod, haddock, pollock, and ocean perch in the U.S. Grade A frozen fillet form. During the same period, processor sales of the same species to retail stores throughout the United States were 42,490 pounds. (The processor was also involved in the production of other species and other market forms at the same time.) A sizeable inventory of 41,142 pounds (83,632 pounds produced minus 42,490 pounds sold) was built up at the

end of this period.

Production volumes were much higher in January and February than in other months (Table 1), and peak production occurred in February. Sales volumes were highest in January (Table 2). Peak production and sales volumes were seen for haddock frozen fillets.

### Production Costs

Unit cost for the production of frozen U.S. Grade A fillets (Table 3) was \$1.74 per pound. No overhead costs are included in this estimate. In particular, the high cost of raw material must be noted. This cost must be ascribed not only to the organizational structure of the business itself: The processor participating in the study was buying already filleted (rather

than whole) fish. This cost must also be ascribed to the exceptional weather conditions prevailing when the production of U.S. Grade A frozen fillets was initiated: In December and January, New England harbors were frozen, and in March and April exceptionally high winds prevailed. Fish landed were sold at premium prices.

The cost differential to produce U.S. Grade A or ungraded frozen fillets was estimated by the processor to be approximately \$0.10 per pound. This result agrees with the cost differential to produce U.S. Grade A fresh fish fillets as described earlier.

One of the major items for this cost differential is the inspection cost, estimated to be \$0.045 per pound on an actual basis and \$0.013 per pound at full and exclusive production of graded fish. To either one of these figures, one must add a few more cents for additional trimming to improve the aesthetic appearance of the product and/or eliminate the presence of bones and other defects as required by the U.S. Grade A standard. The majority of other costs can be assumed to be identical for graded and ungraded products.

### Processor Markups

As can be seen in detail from Table 4, processor markups varied from a low of \$0.42 per pound to a high of \$0.96 per pound. Taking into account quantities sold for each species, the overall weighted average markup was \$0.78 per pound.

Markups are equal to sales prices minus costs of raw material. Both prices are given here as weighted averages: \$2.24 per pound for sales prices and \$1.46 per pound for costs of raw material. Processor costs of raw material and sales prices are not given in detail to avoid disclosure of proprietary information.

### Processor Profit Margin

Subtracting raw material costs (Table 3) from overall production costs, one obtains a "gross" production cost of \$0.28 per pound: This figure does not include overhead costs.

Subtracting from the overall weight-

ed average markup (\$0.78) the figure for gross production cost (\$0.28) one obtains a "gross" profit margin for the processor of approximately \$0.50 per pound. Profit margins are equal to markups minus costs of production.

### Retail Sales

During the study, total retail sales in the test stores were 20,384 pounds of fresh and frozen fish fillets (Table 5). Of these, 12,997 pounds (64 percent of the total) were fresh fish fillets; 3,879 pounds (19 percent of the total) were

ungraded frozen fillets. U.S. Grade A frozen fillets were 3,508 pounds, representing 17 percent of total fish sales.

The pounds of U.S. Grade A frozen fillets purchased for various technological tests by the Gloucester Laboratory should have been subtracted from these totals. However, they were not because the amount (about 200 pounds) was small, and they were observed as actual sales by the retailer.

More meaningful breakdowns are presented in Tables 6, 7, and 8. Table 6 includes the breakdown of retail sales

Table 4.—Processor markups in dollars per pounds, by month.

Species	Jan.	Feb.	Mar.	Apr.	May	June
Cod	\$0.732	\$0.68	NA <sup>1</sup>	\$0.762	\$0.60	\$0.70
Haddock	0.596	0.957	NA	NA	0.54	NA
Pollock	0.55	0.419	\$0.459	0.551	0.55	NA
Ocean perch	0.87	0.762	0.579	0.943	NA	NA

<sup>1</sup>NA = Not available.

Table 5.—Total retail sales by type, in pounds.

Type of sales	Retail sales (pounds)	Percentage of total sales
Frozen Grade A	3,508	17%
Frozen ungraded	3,879	19%
Fresh	12,997	64%
Total	20,384	

Table 6.—Total retail sales by week (in pounds).

Item	Retail sales by week													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Grade A	68	115	313	506	289	314	313	388	425	447	172	24	60	70
Ungraded	437	427	503	354	287	279	260	137	263	368	309	30	140	85
Fresh	808	555	1,125	2,030	1,546	1,236	1,334	1,010	583	1,351	688	216	205	310
Total	1,313	1,097	1,945	2,890	2,122	1,829	1,907	1,535	1,271	2,166	1,169	270	405	465
Percentages														
Grade A	5%	10%	16%	18%	14%	17%	16%	25%	33%	21%	15%	9%	15%	15%
Ungraded	33%	39%	26%	12%	14%	15%	14%	9%	21%	17%	26%	11%	35%	18%
Fresh	62%	51%	58%	70%	72%	67%	70%	66%	46%	62%	49%	80%	50%	67%

Table 7.—Total retail sales by store (3-week period), in pounds.

Item	Store number				
	1	3	7	8	9
Frozen Grade A	10	29	60	—	39
Frozen ungraded	13	301	250	250	95
Fresh	742	271	460	140	100
Total	765	601	770	390	234
Percentages					
Frozen Grade A	1%	5%	8%	—	16%
Frozen ungraded	2%	50%	32%	64%	42%
Fresh	97%	45%	60%	36%	42%

Table 8.—Total retail sales by store (from 11 to 14 week period), in pounds. Store No. 10 remained in the study for 11 weeks; all other stores remained for 14 weeks.

Item	Store number				
	2	4	5	6	10
Frozen Grade A	663	478	1,391	105	733
Frozen ungraded	251	623	710	635	751
Fresh	3,800	1,814	2,515	2,321	834
Total	4,714	2,915	4,616	3,061	2,318
Percentages					
Frozen Grade A	14%	16%	30%	3%	32%
Frozen ungraded	5%	22%	15%	21%	32%
Fresh	81%	62%	55%	76%	36%

by week. The most important figures to notice are those for the first 9 weeks of the study. They show that in this short period retail sales for U.S. Grade A frozen fillets almost consistently grew from 5 to 33 percent of total fish sales. In subsequent weeks there was a decline. We will later present these figures graphically and discuss them more extensively.

Table 7 presents figures for the five stores which participated in the study only for the first 3 weeks. Worthy of note is Store No. 9 in which sales for the U.S. Grade A frozen fillets were 16 percent of total fish sales. This is an indication that sales of this product can quickly become rather substantial.

Table 8 presents figures for the five stores in which records were collected for the longest period of time. These are the stores which are presented in relation to their geographic location in Figure 2. Correlating Table 8 with Figure 2, it appears that sales of U.S. Grade A frozen fillets were the lowest (3 percent of total fish sales for the store) in the poorest area of downtown Albany (Store No. 6); sales were average (14 and 16 percent of total fish sales for the stores) in the high income areas of uptown and suburban Schenectady (Stores No. 2 and 4); and they were the highest (30 and 32 percent of total fish sales for the stores) in the

middle income areas of the western periphery of Schenectady and the northern periphery of Albany (Stores No. 5 and 10).

### Retail Sales Trends

As we have seen, retail sales trends varied considerably from week to week. However, smoothing out minor variations, one can detect an increasing trend up to the ninth week of the study and a declining trend in subsequent weeks. Why the decline?

A first hypothesis was that retail prices had a negative influence on sales. Since data for many variables such as customers' income, price and quantity of substitute products, number of repeat orders, advertising expenses, amount of display area, etc., were either not available or not fully correlated, it was not possible to make a regression analysis of the issue. Besides, as can be seen from Table 9, retail prices varied too widely from type to type, species to species, and week to week to have any clear-cut influence on sales. Nor could one attribute the decline in sales from the tenth week to increasing prices. (Indeed, the reverse was the case.)

Upon this realization, a different analysis was performed. It was assumed that "quality" might be the major explanatory variable to determine

not only the variations in sales but especially the decrease in the sales trend that, as can be seen from Table 6, started to occur from the tenth week of observation. This trend is more clearly visible when the data is presented graphically (Fig. 3). Percentages of sales rather than absolute values were used not only to eliminate the variations that are inherent in the raw data, but also to have two comparable scales between sales and quality.

The regression line of quality scores superimposed on Figure 3 is derived from a current study<sup>3</sup> which analyzes various aspects of the product under observation. Samples of the product were collected at various stages in their production and distribution and evaluated on a 1 to 9 scale for appearance, odor, flavor, and texture. The results varied from species to species. What is here superimposed on Figure 3 is the regression line that results from aggregating the scores for all quality attributes and all species. The demarcation line between U.S. Grade A and Grade B standard, roughly indicated as an overall score of 5, is also plotted on Figure 3.

<sup>3</sup>U.S. Grade A Frozen Fish Program — Technological Report" by J. M. Mendelsohn, NMFS Gloucester Laboratory, Gloucester, Mass. In prep.

Table 9.—Retail chain prices (dollars per pound) by week.

Item	Retail price by week													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Frozen Grade A														
Cod	\$3.49	\$3.49			\$2.99	\$3.19	\$3.19		\$3.19	\$3.19	\$2.69	\$2.69		
Haddock	3.49	3.49		\$2.99	2.99	3.29	2.98		3.29	3.29	3.29	2.89		
Pollock	2.09	2.09	NA <sup>1</sup>		2.09	1.99	1.99	NA	2.09	2.09	2.09	2.09	NA	\$2.09
Flounder	3.89	3.89		2.99	3.89	3.89	3.89		3.89	3.89	3.89	3.89		
Ocean perch	3.69	3.69			3.69	2.98	2.98		3.69	3.69	3.69	3.69		
Frozen Ungraded														
Cod	1.49	1.49			1.49	1.49	1.49		1.49	1.49	1.49	1.49	\$1.49	
Haddock	1.98	1.98		1.89	1.98	1.79	1.79	NA	1.98	1.98	1.98	1.98		
Pollock	1.29	1.29	NA		1.29	1.29	1.29		1.29	1.29	1.29	1.29		NA
Flounder	2.29	2.29			2.29	2.29	2.29		2.29	2.29	2.29	1.98		
Ocean perch	1.59	1.59			1.59	1.59	1.59		1.59	1.59	1.59	1.59		
Fresh														
Cod	3.19	3.29		2.29	3.59	3.09	3.09	\$2.59	3.29	4.39				
Haddock	2.99	2.89	NA	2.49	3.89	3.19	3.19	\$2.89	3.69	4.39				2.29
Pollock		2.09		2.19	1.89	2.09	2.09	1.98	2.65	2.69	NA	NA	NA	
Flounder	4.49			4.19		4.09	4.09	3.19	3.79	4.79				
Ocean perch	3.99	3.79			3.89	3.89	3.19	3.79	3.98					

<sup>1</sup>NA = Not available.

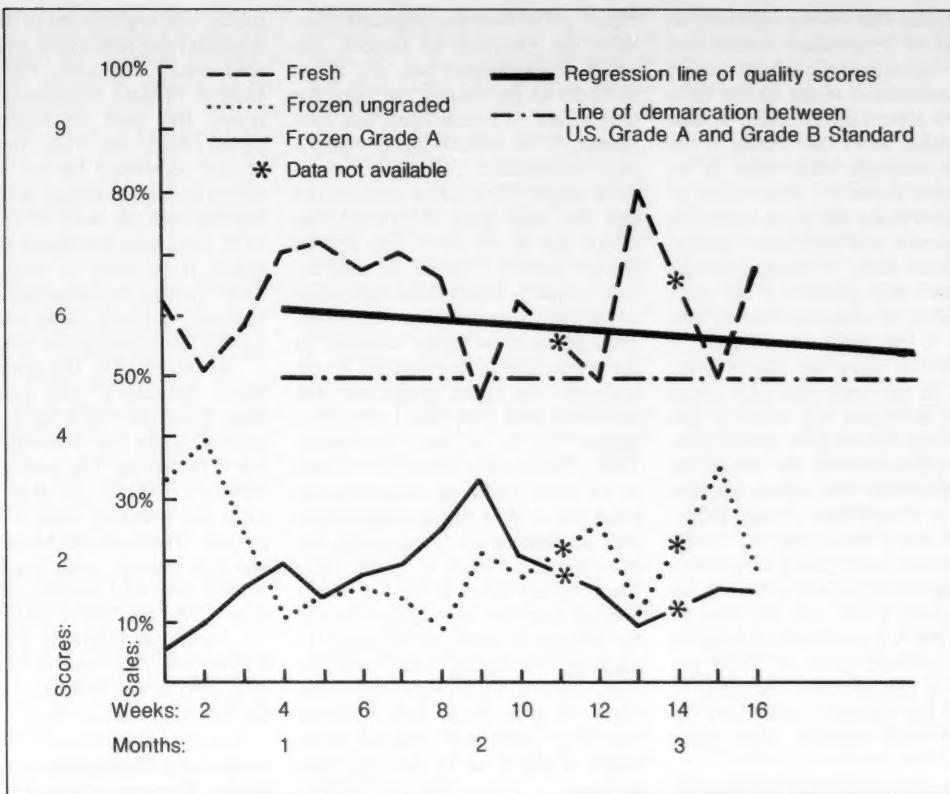


Figure 3.—Quality scores and sales as a percentage of total fish sales.

Observing the relationship between the sales trend for U.S. Grade A frozen fillets and the corresponding regression line of quality scores, one can detect a rather close correlation between the two. Even though the samples never showed very high quality scores, it is still possible to observe that when they were at an overall quality rating of 6 (and presumably higher during the first weeks of observation) the sales trend was moving upward. When the overall quality score approached a value of 5, a borderline value, the sales trend was almost consistently sloping downward.

This correlation, at least on a tenta-

tive and partial basis, seems to verify the validity of the hypothesis under which this study was conducted: High quality produces sales, low quality does not. But certainly, as in all scientific investigations, this relationship needs to be confirmed by other and more extended periods of observation.

There are a host of issues involved not only in the declining sales trend starting with the tenth week of the study but also in the explanation for the progressive degradation of the quality of the product during its stay at the retail level. The overriding factors, however, as the Mendelsohn report (footnote 3) will show, were lack of

temperature control in the display cases and lack of strict adherence to quality control procedures. In addition, there were some wholly unrelated causes: The tenth week of the study coincided with the week of Good Friday in 1981, an occasion apparently associated with the consumption of fresh rather than frozen fish; and the eleventh week coincided with the coming of spring, a season in which fresh fish starts to become again plentiful and less expensive than in winter.

Yet, even unrelated causes can produce the same effect: Fewer sales. Then there are causes which are more directly related to each other. Besides

those causes that belong especially to the field of temperature control and quality maintenance procedures stressed in the companion report on the technological aspects of this study, at least three related issues that belong to the business/economic field need to be mentioned. From the observation of production codes and discussions with the processor and the retailer participating in the study, it became apparent that quality degradation was also partly due, first, to initial overbuying, and second, to low product turnover.

These two issues are closely intertwined, in the sense that high initial volumes determine low turnover and low turnover breeds poor quality. Fish does not improve with the passage of time. And these two causes are also related to a third one: Pricing policy. Table 9 clearly shows that the supermarket chain participating in the study was in search of the best price level for each species. It left only the price of U.S. Grade A frozen fillets of flounder at the constant price of \$3.89 per pound. It changed least the price of pollock, but changed considerably the price of cod, haddock, and ocean perch.

This experimentation with prices, although necessary when introducing a new product, might have had an undesirable negative effect on the consumer. Was the product ever considered "overpriced" or "underpriced"? Was the linkage between high quality and high price ever broken in the mind of the consumer? As we will see, there is some evidence that sales of U.S. Grade A frozen fillets were higher when their price was set at about the same level as for fresh fish. One can find here other partial explanations for the low turnover, the ultimate quality degradation of the product, and the declining sales in the last weeks of the study.

However, while the pricing change policy might have had a negative short-term impact on sales, in the long run it might also have contributed to the disclosure of three basic characteristics concerning the pricing of U.S. Grade A frozen fish fillets. First, graded frozen fillets can be sold at considerably

higher prices than the ungraded ones. With the exception of pollock, for which the difference was still about \$0.70-\$0.80 per pound, the price for U.S. Grade A frozen fillets was consistently \$1.00 to \$2.00 higher than the price of ungraded frozen fillets of the same species. (It must be remembered that this large price differential was mostly due to the initial high cost of the raw material.) Second, the price for U.S. Grade A frozen fillets was generally as high as the price for fresh fillets. Thus an assumed major deterrent to the production of high quality frozen seafoods—the higher production cost and lower sales price than fresh fish—appears to be without foundation. Third, high quality frozen fillets seem to sell more briskly at higher than at lower prices. With the exception of the price for flounder and ocean perch, the price for U.S. Grade A frozen fillets was generally higher in the first weeks—when sales were increasing—than in the subsequent weeks of the study. In addition, correlating retail sales by week (Table 6, Fig. 3) with retail prices (Table 9), gives *prima facie* evidence that when prices were lowered, as in weeks 4 and 5 or 11 and 12, sales declined.

This last relationship is contrary to what generally happens with most products. Higher prices are supposed to dampen sales. However, the above characteristics are all indications that the product is indeed perceived as a "high-quality" product, and, perhaps more important, that the initial high price encourages rather than deters sales.

The full explanation for the willingness of the consumer to pay high prices for a high quality product can be found not only in such sociological factors as "status symbol" or "conspicuous consumption," but also in a combination of formal opportunity cost theory and marginal economic analysis. It is wiser to spend one or two additional dollars per pound than to avoid this extra expense and find the product almost completely worthless.

### Normalcy of Trends

From the observation of the above

trends, one might be led to the conclusion that retail sales trends were erratic. And indeed they were. However, an analysis of data concerning sales of frozen fish over an almost 2-year period reveals that erratic trends are a normal occurrence for the chain and not an aberration limited to this study. Starting with the week of 21 October 1979, retail sales for frozen fish varied widely from week to week. Rather than reporting the entire series of data, however, only spot checks will be mentioned. Thus, during the week ending 11 November 1979, the percentage of frozen fish sales of total meat department (meat and fish) sales was 0.32 percent, while the following week it was 0.19 percent. The week ending 17 February 1980 it was 0.46 percent, while the following week it was 0.38 percent. The week 16 March 1980 it was 0.39 percent, while the following week it was 0.63 percent. The week ending 29 June 1980 it was 0.24 percent, while the following week it was 0.19 percent. The week ending 10 August 1980 it was 0.30 percent, while the following week it was 0.09 percent.

Available data for some of the same weeks the following year show similar results. The week ending 15 February 1981 the percentage of frozen fish sales over total meat department sales was 0.40 percent, while the following week it was 0.26 percent. The week ending 15 March 1981 it was 0.31 percent, while the following week it was 0.40 percent. The week ending 28 June 1981 it was 0.26 percent, while the following week it was 0.19 percent.

In the end, it might be in the very nature of fish—and especially frozen fish—that sales are erratic for all supermarkets rather than being peculiar to the chain participating in this study. As far as fresh fish is concerned, the season and the weather conspire to create those erratic trends. And as for frozen fish, the consumer might prefer to stock up the freezer rather than to buy a regular supply each week.

### Retail Markup

Averaging all retail prices reported in Table 9 with the exclusion of the prices for flounder to have comparable

figures with processor sale prices and weighting them by the amounts sold, one obtains the weighted average of \$3.12 per pound. Averaging all processor sale prices, as we have seen, one obtains the weighted average of \$2.24 per pound. Subtracting the latter from the former figure, one obtains a retailer markup of \$0.88 per pound.

### **Retailer Profit Margin**

Assuming retail costs (including labor, refrigeration, discards, etc.) to be in the order of \$0.20 per pound, it is possible to conclude that the retailer's "gross" profit margin was approximately \$0.68 per pound. Not only is this a broad estimate, it must also be considered as a gross profit margin because it does not even attempt to estimate overhead costs.

### **Conclusions**

On the basis of the preceding findings, it is now possible to answer three fundamental questions which have been implicitly addressed in this report: Does the product sell? How much of it can be sold, and at what price? Does it yield a profit?

### **Does the Product Sell?**

Within the confines of this study, the question as to whether it is possible to sell U.S. Grade A frozen fillets can be given a qualified positive answer. The product sells quite well in stores located in middle income neighborhoods. It sells less well in upper income neighborhoods, and it sells poorly in low income neighborhoods. The overall result of 17 percent of all fish sales is an indication that it is possible to sell U.S. Grade A frozen fish fillets. The essential condition is that the product be indeed of high quality.

These conclusions are brought forward by the apparent relationship between quality scores and sales trends. In addition, these conclusions are brought forward not only by the systematic analysis reported above, for, during a relatively short period of time, sales of U.S. Grade A frozen fillets—essentially a new product—surpassed 30 percent of the total fish sales in the two middle income neighbor-

hoods. These conclusions are also brought forward by spot checks. In Store No. 5, during the ninth week of the study, sales of U.S. Grade A frozen fillets had reached 41 percent of total fish sales in that store.

Finally, these conclusions are corroborated by evidence gathered outside the confines of this study. Pier 12, the brand name of the product under study, was reported to be "the fastest moving frozen brand" by Dave Conner, the seafood coordinator of Beyerly's St. Louis Park supermarket in Minnesota. "It outsells any of the frozen fish, I would say, 10 to 1," Conner says. "There is no frost buildup, no freezer burn and no shrinkage. It is a high-quality product" (Cole, 1981).

### **How Much and At What Price?**

The question of how much U.S. Grade A frozen fish can be sold, and at what price, is complex and can be only partially answered through this study. Since this is essentially a new product, it is perhaps too early to say how much of it can be sold. In any case, this part of the question might be better answered through a national marketing study.

The second part of the question, however, can be answered here. U.S. Grade A frozen fillets appear to be selling better at higher than at lower prices. Sales were higher when the price was set at about the same level as fresh fish fillets.

Looking at it from another point of view, it is possible to say that customers were willing to pay up to \$2.00 more per pound for graded than for ungraded products.

### **Does It Yield a Profit?**

The question as to whether producing and selling U.S. Grade A frozen fillets yield a profit must also be given a qualified positive answer. As the study shows, there seems to be a high "gross" margin of profit for the retailer—about \$0.68 per pound.

The "gross" margin of profit for the processor appears to have been about \$0.50 per pound. Indeed, considering the initial inventory accumula-

tion and accompanying interest charges, it is questionable whether the processor earned a net profit on the production of U.S. Grade A frozen fillets while this study was underway. Part of the explanation for the lower profit margin and the initial inventory accumulation must be found not only in the very nature of the business—namely introductory costs for a new product are always high and full profits can be expected only after a substantial period of maturation—but even in the organizational structure of the business itself. The processor was not buying whole fish, but already filleted fish. Thus the operation had to allow for profits for still another enterprise. Finally, the profit margin for the processor was also affected by the high price of raw material due to exceptional weather conditions prevailing when the experiment was conducted.

In summary, the most important conclusions to be drawn from this study are that: 1) It is possible to sell U.S. Grade A frozen fish fillets; 2) consumers are ready to pay from \$1.00 to \$2.00 more per pound for the graded than the ungraded product, a price differential determined especially by the initial high cost of raw material; and 3) considering retail prices vs. the low cost differential for the production of graded and ungraded fillets (about \$0.10 per pound), there is no question as to the profitability of assuring the quality of frozen fillets to the consumer.

In addition, as the study shows, there is a question of distribution of profits. In the short run, the question concerns the profit distribution between retailer and processor(s). In the long run, one must fully expect that the very forces of competition, different initial conditions regarding the raw material, and increased consumer acquaintance with the product will eventually introduce two new actors in the distribution of the profits: The consumer and the fisherman.

As a general result of this study, it can therefore be concluded that a program of Quality Assurance has a high probability of success in solving the very core of the problem associated

with the sale of frozen fish fillets in the United States: High quality frozen fish fillets can be produced at comparatively low cost and can be sold at a price almost as high as the price of fresh fish. If this program is persistently implemented, it seems that it is indeed possible to exploit the vast potential offered by the frozen fish market in the United States (Nickerson and Ronsivalli, 1979).

### Recommendations

Rather than listing a whole array of recommendations that transpire through this study, it might be more appropriate to express only three basic recommendations.

First, the processor should try to consolidate fish cutting operations under the umbrella of only one enterprise. Steps toward this end have already been taken by the processor.

Second, the retailer should try to have a better coordination between purchases and sales. With the difficulty of controlling temperatures at the retail level, and with a product ultimately as perishable as even frozen fish is, at least at the beginning of a new sales program it is better to under-buy than to over-buy. Quick turnover is an automatic quality controller. The retailer, too, is already taking steps to implement this recommendation.

A final recommendation is broadly directed to all those who are concerned with the production and sale of fish, rather than specifically to the processor and retailer participating in this study who are already implementing this recommendation. It should be remembered that the original purpose of the endeavor analyzed here is not simply to introduce a new product on the

market but to preserve as much fish in the U.S. Grade A standard of quality as possible, thus eliminating damaging peaks and valleys in both prices and supplies. As stressed by various sources (i.e., Gorga et al., 1979), the real need is for an organic program of fish production and distribution, combining both fresh and frozen products: All fish that can be sold fresh should be so sold; the rest should be frozen while it is in a U.S. Grade A quality condition.

### Acknowledgments

This study could not have been carried out without the continuing collaboration from Gus Aslanis, President of Aslanis Fisheries, Boston, Mass., and his assistants Dick Hallinan and Patricia A. Tamasi. Equally indispensable was the continuing assistance from Anthony Tasso, Meat Department Manager of Gallup Corporation (Price Chopper), Albany, N.Y., and his assistants Carmen Julian and Barbara Hodoroski. Barbara Hodoroski and Patricia Tamasi have to be especially singled out for their invaluable assistance in the collection, elaboration, and transmittal of much information.

Special thanks go to the following Meat Managers for their painstaking collection of weekly data: Thomas Adriano, Julio Frizzzone, Robert Longo, William McCormack, and Michael Patterson.

Thanks for the preparation of computer files and for cheerfully giving instructions on computer manipulation go to Pesi J. Amaria, consultant to the Gloucester Laboratory. Continuing help for computer manipulation was

received from Kurt A. Wilhelm of the same laboratory. The report also benefited from incisive comments by Joseph J. Mueller, economist with the Northeast Regional Office of NMFS.

Finally, it must be acknowledged that the study as a whole stems from the quality assurance strategies designed by John T. R. Nickerson, Professor Emeritus, Massachusetts Institute of Technology, and expert consultant to the Gloucester Laboratory and by Louis J. Ronsivalli, former Director of the Gloucester Laboratory.

### Literature Cited

- Anonymous. 1961. Frozen fried fish sticks. *Consum. Rep.* 26:80-83.
- Anonymous. 1981. Seafoods: 'Seafood illiteracy,' trend to fresh at root of frozen fish sales lag: Safeway head. *Quick Frozen Foods* 43(12):51-54, 60.
- Cole, J. B. 1981. Midwest retail: At Beyerly's, seafood pays. *Pac. Packers Rep.* 79(2):28-33.
- Gorga, C., J. D. Kaylor, J. H. Carver, J. M. Mendelsohn, and L. J. Ronsivalli. 1979. The economic feasibility of assuring U.S. Grade A quality of fresh seafoods to the consumer. *Mar. Fish. Rev.* 41(7):20-27.
- \_\_\_\_\_, and L. J. Ronsivalli. 1982. International awareness for quality seafoods: A survey. *Mar. Fish. Rev.* 44(2):11-16.
- \_\_\_\_\_, and \_\_\_\_\_. 1981. The importance of the U.S. seafood industry. *Seafood Am.* 1(7):26-27, 34.
- Nickerson, J. T. R., and L. J. Ronsivalli. 1979. High quality frozen seafoods: The need and the potential in the United States. *Mar. Fish. Rev.* 41(4):1-7.
- Ronsivalli, L. J., C. Gorga, J. D. Kaylor, and J. H. Carver. 1978. A concept for assuring the quality of seafoods to the consumer. *Mar. Fish. Rev.* 40(1):1-4.
- \_\_\_\_\_, J. D. Kaylor, P. J. McKay, and C. Gorga. 1981. The impact of the assurance of high quality of seafoods at point of sale. *Mar. Fish. Rev.* 43(2):22-24.
- \_\_\_\_\_. 1981. U.S. seafood industry's big opportunity—quality assurance. *Seafood Am.* 1(9):24-28.
- USDOC. 1981. Fisheries of the United States, 1980. U.S. Dep. Commer., NOAA, Natl. Mar. Fish. Serv., *Curr. Fish. Stat.* 8100, 132 p.

# Adult Coho Salmon Recoveries and Their $\text{Na}^+\text{-K}^+$ ATPase Activity at Release

ROY J. WAHLE and WALDO S. ZAUGG

## Introduction

Many studies have examined relationships between quantitative changes in gill  $\text{Na}^+\text{-K}^+$  adenosine triphosphatase ( $\text{Na}^+\text{-K}^+$  ATPase) activity and migrational behavior in juvenile Pacific salmon, *Oncorhynchus* spp., and steelhead trout, *Salmo gairdneri*, (Ewing et al., 1980; Hart et al., 1981; Zaugg and McLain, 1972; Zaugg and Wagner, 1973). Although the role of this enzyme in the gill is not fully understood, it is believed to be an integral factor in "pumping" excess  $\text{Na}^+$  ions from tissue back into the environment, particularly after the fish enters seawater. This physiological process maintains a proper balance of electrolytes throughout the body (Wedemeyer et al., 1980; Folmar and Dickhoff, 1980; and Epstein et al., 1980).

Gill  $\text{Na}^+\text{-K}^+$  ATPase activity has been intensively studied in coho salmon, *O. kisutch*, and is observed to increase in fresh water during the spring of the second year (Zaugg and McLain, 1970, 1972, 1976; and Lasserre et al., 1978). This increase in activity appears to be associated with volitional seaward migration as well as with tolerance and adaptability of the fish to seawater. Knowing seasonal ranges of gill  $\text{Na}^+\text{-K}^+$  ATPase activity

might help hatchery personnel determine proper release times for coho salmon to achieve optimal seawater performance, an important factor in overall survival.

This study examines adult recoveries of hatchery-reared coho salmon whose release as normal yearlings during April and May 1976 was coordinated with gill  $\text{Na}^+\text{-K}^+$  ATPase activity levels. Fish were released from two separate hatcheries at two separate times: 1) Before reaching maximum enzyme activity, and 2) at or near peak  $\text{Na}^+\text{-K}^+$  ATPase levels.

## Experimental Procedures

The 1974 brood coho salmon used were normal production fish reared on

the Oregon Moist Pellet diet at Willard National Fish Hatchery (NFH) on the Little White Salmon River in Washington and at Eagle Creek NFH on a tributary of the Clackamas River in Oregon.

The freshwater study period was from early March to late May 1976. In March four groups of approximately 100,000 fish each were removed from the production ponds, marked, and put into separate ponds. The mark was an adipose fin-clip coupled with a coded-wire tag imbedded in the cartilage above the nares (Bergman et al., 1968). This technique is routinely used in salmonid experiments on the Pacific Northwest coast. Fish are identified in the various fisheries and hatcheries by the adipose fin clip mark, and the individual experiments are identified by removing the wire tag and identifying the binary code number.

During marking, about 2,000 fish from each of the four groups were randomly sampled to estimate the tag retention rate. The fish were released from Willard NFH on 27 April 1976 and 17 May 1976 and from Eagle Creek NFH on 28 April 1976 and 24 May 1976. Eighteen fish were removed by dip net from each test pond every 2



Gill filaments are taken for  $\text{Na}^+\text{-K}^+$  ATPase analysis.

Roy J. Wahle is with the Environmental and Technical Services Division, Northwest Regional Office, National Marine Fisheries Service, NOAA, 847 N.E. 19th Avenue, Suite #350, Portland, OR 97232. Waldo S. Zaugg is with the Coastal Zone and Estuarine Studies Division, Northwest and Alaska Fisheries Center, National Marine Fisheries Service, NOAA, Star Route, Cook, WA 98605.

weeks until release. Gill samples from six fish were pooled for ATPase determination (assayed in duplicate), thus giving three points for each pond for each sampling date. The  $\text{Na}^+\text{-K}^+$  ATPase activities were determined as

previously reported (Zaugg and McLain, 1976) with centrifuging times reduced one-half, and are reported as  $\mu\text{M Pi/mg protein}^{-1} \cdot \text{h}^{-1}$ .

### $\text{Na}^+\text{-K}^+$ ATPase Activity and Survival

$\text{Na}^+\text{-K}^+$  ATPase activity in the gills of coho salmon from Eagle Creek and Willard NFH increased during April and May 1976 (Fig. 1). ATPase activity in fish gills from Eagle Creek NFH rose more uniformly and to a greater level than in the Willard hatchery coho. A profile of gill  $\text{Na}^+\text{-K}^+$  ATPase activity obtained from coho salmon at Willard NFH in 1978 is shown for comparison with that of salmon released in 1976 (Fig. 1). Although the 1976 data were more erratic than the 1978 data, it is reasonable to assume that since climatic conditions were normal, the May release occurred near or at maximum activity. The first release from each hatchery occurred while the ATPase activities were still increasing; the second release occurred near or at peak activity in both the Eagle Creek and Willard NFH coho salmon.

The estimated total percentage recovery in all fisheries sampled plus hatchery returns from the late groups was 2.8 times more than the early release group for the Willard NFH coho and 3.1 times more than the early group for the Eagle Creek NFH fish (Table 1). These data also indicate that there were no appreciable geographic

distribution shifts made by these two stocks due to delayed release. However, geographic distribution variations have been shown to occur with delayed releases of some salmon stocks (Novotny, 1980).

### Implications

The results indicate that time of release from the hatchery and survival through maturity are related. Further evidence indicates that releasing coho salmon later than the normal late-April or early-May period has increased total survival as much as fourfold in other Columbia River hatcheries (Novotny, 1980). There is also evidence that survival can be increased still further by the correct combinations of fish size and time of release (Bilton, 1980; Novotny, 1980).

One possible factor contributing to the greater survival of coho salmon released later than normal is their marked increase in seaward migration rates (Zaugg, In press a, b). Coho released in June and July 1979 from three hatcheries on the Columbia River and its tributaries migrated nearly twice as fast as fish released in May, despite lower water flows. Although the June and July releases occurred after gill  $\text{Na}^+\text{-K}^+$  ATPase activities had returned to lower levels, these fish rapidly re-elevated enzyme activities once they were liberated from the hatcheries. May releases, on the other hand, were made near peak ATPase activity. There is now evidence that fall

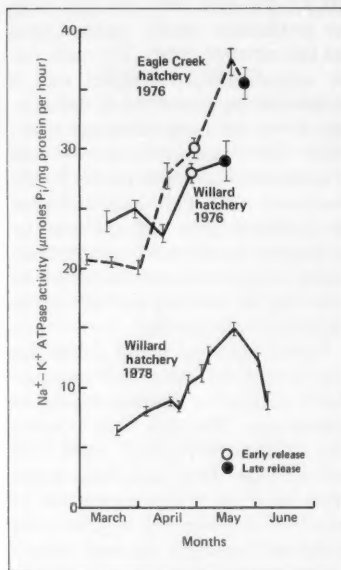


Figure 1.—Gill  $\text{Na}^+\text{-K}^+$  ATPase activities of coho salmon at Eagle Creek and Willard National Fish Hatcheries in 1976. For comparative purposes ATPase activities using a less purified enzyme preparation are shown for Willard NFH in 1978.

Table 1.—Number marked, average weight, percentage tag retention, and ATPase activity of coho salmon released from Willard and Eagle Creek National Fish Hatcheries and the areal distribution of recoveries by time of release.

Catches and the area distribution of recoveries by date of release <sup>1</sup>												
Hatchery	Date of release	Number of fish marked	Percent tag retention	Average fish weight (gm)	ATPase activity	Recoveries					Total number	Per-centage of release
						Fishery area and hatchery <sup>1</sup>						
						Wash.	Oregon	Calif.	Col. Riv.	Hatchery		
Willard	4/27/76	95,901	96.1	18.4	Ascending	107 (13.9)	224 (29.1)	14 (1.8)	16 (2.1)	408 (53.1)	769	0.8
	5/17/76	95,408	96.4	20.9	Maximum	339 (16.0)	300 (14.2)	4 (0.2)	68 (3.2)	1,404 (66.4)	2,115	2.2
Eagle Creek	4/28/76	97,931	97.4	29.3	Ascending	324 (37.4)	321 (37.1)	13 (1.5)	48 (5.6)	159 (18.4)	865	0.9
	5/24/76	96,608	96.6	34.1	Maximum	832 (31.3)	896 (33.7)	116 (4.4)	204 (7.7)	610 (22.9)	2,658	2.8

<sup>1</sup>Number of fish above and (in parentheses) percentage of total recoveries.

chinook salmon, *O. tshawytscha*, released before developing elevated gill  $\text{Na}^+\text{-K}^+$  ATPase activity, migrate seaward much more slowly than fish released during or after enzyme activity development (Zaugg, In press b). It is likely that coho salmon exhibit the same characteristics; the April releases from the Willard and Eagle Creek NFH did not migrate as rapidly as fish released in May. In addition, fish released in April were probably more subject to predation than were fish released in May.

Also, later releases may have survived better because more food was available both in the river and the ocean. Nevertheless, if speed of seaward migration is important for overall survival, then release timing becomes important in its regulation. The level of gill  $\text{Na}^+\text{-K}^+$  ATPase activity can be used as an indicator to time releases for maximum migration speed.

Although total recoveries of released 1974 brood coho salmon from Willard and Eagle Creek NFH were not high (Table 1), the data suggests that coho salmon releases based on the gill  $\text{Na}^+\text{-K}^+$  ATPase activity cycle will result in increased total returns to hatcheries. More extensive studies of the relation-

ship between release time and survival through maturity were undertaken in 1978, 1979, and 1980, and a cursory examination of the available data from these releases clearly supports the results of the early study.

### Literature Cited

- Bergman, P. K., K. B. Jefferts, H. F. Fiscus, and R. C. Hager. 1968. A preliminary evaluation of an implanted coded wire fish tag. Wash. Dep. Fish., Fish. Res. Pap. 3:63-84.
- Bilton, H. T. 1980. Experimental releases of coho salmon in British Columbia. In J. G. Thorpe (editor), Salmon ranching, p. 305-324. Acad. Press, Lond.
- Epstein, F. H., P. Silva, and G. Kormanik. 1980. Role of  $\text{Na}^+\text{-K}^+$  ATPase in chloride cell function. Am. J. Physiol. 238 (Regulatory, Integrative Comp. Physiol. 7):R246-R-250.
- Ewing, R. D., C. A. Fustich, S. L. Johnson, and H. J. Pribble. 1980. Seaward migration of juvenile chinook salmon without elevated gill  $\text{Na}^+\text{-K}^+$  ATPase activities. Trans. Am. Fish. Soc. 109:349-356.
- Folmar, L. C., and W. W. Dickhoff. 1980. The parr-smolt transformation (smoltification) and seawater adaptation in salmonids: A review of selected literature. Aquaculture 21:1-37.
- Hart, C. E., G. Concannon, C. A. Fustich, and R. D. Ewing. 1981. Seaward migration and gill ( $\text{Na}^+\text{-K}^+$ ) ATPase activity of spring chinook salmon in an artificial stream. Trans. Am. Fish. Soc. 110:44-50.
- Lasserre, P., G. Boeuf, and Y. Harache. 1978. Osmotic adaptation of *Oncorhynchus kisutch* Walbaum. I. Seasonal variations of  $\text{Na}^+\text{-K}^+$  ATPase activity in coho salmon. 0+ age and yearling, reared in fresh water. Aquaculture 14:365-382.
- Novotny, A. J. 1980. Delayed release of salmon. In J. G. Thorpe (editor), Salmon ranching, p. 325-369. Acad. Press, Lond.
- Wedemeyer, G. A., R. L. Saunders, and W. C. Clarke. 1980. Environmental factors affecting smoltification and early marine survival of anadromous salmonids. Mar. Fish. Rev. 426:1-14.
- Zaugg, W. S. In press a. Some changes in smoltification and seawater adaptability of salmonids resulting from environmental and other factors. Aquaculture.
- \_\_\_\_\_. In press b. Relationships between smolt indices and migration in controlled and natural environments. In Salmon and trout migratory behavior symposium, June 1981, Seattle, Washington. Univ. Wash. Press, Seattle.
- \_\_\_\_\_, and L. R. McLain. 1970. Adenosine triphosphatase activity in gills of salmonids; seasonal variations and salt water influence in coho salmon, *Oncorhynchus kisutch*. Comp. Biochem. Physiol. 35:587-596.
- \_\_\_\_\_, and \_\_\_\_\_. 1972. Changes in gill adenosine triphosphatase activity associated with parr-smolt transformation in steelhead trout, coho, and spring chinook salmon. J. Fish. Res. Board Can. 29:167-171.
- \_\_\_\_\_, and \_\_\_\_\_. 1976. Influence of water temperature on gill sodium, potassium stimulated ATPase activity in juvenile coho salmon *Oncorhynchus kisutch*. Comp. Biochem. Physiol. 54A: 419-421.
- \_\_\_\_\_, and H. H. Wagner. 1973. Gill ATPase activity related to parr-smolt transformation and migration in steelhead trout (*Salmo gairdneri*); influence of photoperiod and temperature. Comp. Biochem. Physiol. B, Comp. Biochem 45:955-965.

# Chemical Composition and Frozen Storage Stability of Spot, *Leiostomus xanthurus*

MELVIN E. WATERS

## Introduction

Spot, *Leiostomus xanthurus*, is one of the more abundant finfish inhabiting coastal waters of the southeastern United States. They are bottom dwellers to depths of over 100 fathoms and range from Massachusetts Bay south to the Bay of Campeche (Dawson, 1958; Parker, 1971). In the mid- and south-Atlantic, the commercial fishery is centered in the Chesapeake Bay area and in the Carolinas, where the fish are harvested mainly for food.

Spot are harvested in the Carolinas

**ABSTRACT**—Spot, *Leiostomus xanthurus*, was harvested seasonally for a 12-month period to determine the chemical composition and frozen storage ( $-18^{\circ}\text{C}$ ) stability of the filleted and minced forms of flesh. One-pound blocks were prepared, frozen, and evaluated after 0, 3, 6, and 12 months of storage. The results indicated that maximum nutritional values and frozen storage stability are obtained from spot harvested from October to February. During this period, the protein content was at its maximum, the fat content decreased to a minimum, and the fatty acids were relatively stable. Amino acid values varied minimally throughout the harvesting period.

Sensory scores showed that filleted spot were preferred over the minced form due to flavor, odor, and color but primarily to the color of the mince. The low level of acceptability of spot (any form) is due to its strong flavor and dark colored flesh. Thiobarbituric acid (TBA) values increased with an increase in fat content and during storage. TBA values were highest for the minced form, however, the sensory panel did not report rancid flavor or odor. Total volatile nitrogen (TVN) values indicated minimal proteolysis during frozen storage.

by beach seine during September and October (Dawson, 1958). In the Gulf of Mexico they are harvested from in-shore waters (out to 50 fathoms), principally by otter trawls in a mixed catch, as a directed fishery for petfood, and to a lesser extent as foodfish. Additionally, a large number of spot are harvested as a by-catch of the shrimp fishery and discarded at sea. Spot is estimated at 8 percent of the shrimp by-catch (Juhl et al.<sup>1</sup>).

In the northern Gulf of Mexico, spot, croaker, and seatrout are the most important finfish in both the commercial and spot fisheries and contribute to the major portion of the industrial bottomfish and foodfish catches (Guttherz et al., 1975). An accurate assessment of the MSY (maximum sustainable yield) of spot is not available but the potential is believed to be substantial. In 1979, the U.S. recreational catch totaled 2.1 million pounds (NMFS, 1981) and the 1980 commercial catch totaled 10.2 million pounds valued at \$2.3 million (Thompson<sup>2</sup>).

<sup>1</sup>Juhl, R., S. B. Drummond, E. J. Guttherz, C. M. Roithmayr, J. A. Benigno, and J. A. Butler. 1976. Oceanic resource surveys and assessment task. A status report presented to the technical coordinating committee of the Gulf States Marine Fisheries Commission, October 1976. On file at National Marine Fisheries Service, Mississippi Laboratories, Pascagoula Facility, Pascagoula, Miss.

<sup>2</sup>B. G. Thompson. National Marine Fisheries Service, NOAA, Office of Science and Environment, Washington, DC 20235. Pers. commun., 20 August 1981.

The average marketable (foodfish) size of spot is about 227 g, ranging from about 113 to 454 g. Hildebrand and Cable (1930) reported a record size of 34.5 cm weighting 624 g and stated, "apparently spot grows larger in the more northern parts of its range than it does farther south and although a common species on the Texas Coast, spot does not attain a sufficiently large size there to be of much commercial value."

Spot is commonly regarded as an underutilized species because of its 1) small size, 2) limited acceptance as a food fish in the market place and 3) primary use in low valued animal food. Spot is generally available as fresh whole fish in retail markets along the mid- and south-Atlantic coasts during the harvesting season and as frozen-thawed fish during the off-season. The nutritional value of spot compares favorably with traditionally-consumed species. The flesh possesses a strong, distinctive fish flavor, is firm, and contains a considerable amount of dark meat along the lateral line, which contributes to the development of rancidity during frozen storage.

The low acceptance of spot in the market place is due primarily to its strong flavor, dark colored flesh and product form (whole) in which it is presented. Preparation of additional forms (headed and gutted, fillets, portions, etc.) have not been attempted because of the high labor costs involved in hand processing small fish. Mechanical processing of small fish in the southeastern United States for human consumption has been minimal in the past but may offer an opportunity to utilize the spot resource economically. Mechanical equipment is available commercially to process this species effectively.

Mechanically deboned fish (mince) has the potential of becoming a major

Melvin E. Waters is with the Charleston Laboratory, Southeast Fisheries Center, National Marine Fisheries Service, NOAA, Charleston, SC 29412-0607. This paper is contribution number 82-26C, Southeast Fisheries Center, National Marine Fisheries Service, NOAA, Charleston, SC 29412-0607.

source of high quality fish protein in the United States (Decker, et al.<sup>3</sup>). Minced croaker is currently being produced commercially as surimi in substantial quantities on the Alabama coast (Thrash<sup>4</sup>). Although croaker is the species of choice in the production of surimi because of its unique physical and chemical properties, species with similar characteristics, such as spot, may be substituted if the croaker resource decreases significantly. Substitution of spot for croaker in the production of surimi is speculation (similarities between species) and requires further research to determine its suitability. Additionally, spot may be used in the mince form in the preparation of fish cakes, fish sticks and portions, seafood stuffings, chowders, and many other products where integrity of the flesh is unimportant. Fillets packaged in small portions (454-908 g) could be used by consumers similarly to other species currently on the market; however, this marketing form is yet to be established.

The frozen storage stability of the various product forms of spot is little known and must be determined if this species is to be effectively used. Chemical composition has been reported by Sidwell (1981) only as a guide to the ranges of nutritional values, but seasonal data are unavailable. It is important to determine the chemical composition and storage characteristics of spot on a seasonal basis to provide the necessary information to produce and process fish of optimum nutritional value and storage stability. The objectives of this study were to: 1) Determine the chemical composition of spot on a seasonal basis for fish harvested from one location and 2) determine the

storage stability of fillet and mince blocks held at  $-18^{\circ}\text{C}$  for 12 months.

## Materials and Methods

### Sample Preparation

Fresh, iced spot were obtained during May, July, October, and November, 1979 and February 1980 from a commercial seafood dealer in North Carolina. In each sampling period, 150 pounds were obtained dockside, iced, and transported to the Charleston Laboratory for processing. The fish were caught off the coast of Morehead City, N.C., 36-48 hours prior to sample preparation. The fish ranged in size from 113 to 340 g and averaged about 227 g each.

Preparation of fillet and mince blocks began immediately upon arrival of the fish at the laboratory. The fish were washed, divided equally into two groups, and weights obtained for product yield. The first group was hand filleted and skinned; fillets were weighed, rinsed in ice water, and drained 5 minutes. The fillets were packed in 1-pound, wax-coated food cartons ( $7.5 \times 21.5 \times 3$  cm). The second group was mechanically scaled, headed, gutted, and deboned, and the minced flesh weighed and packed in 1-pound, waxed food cartons. The fillet and mince blocks were frozen in a plate freezer at  $-40^{\circ}\text{C}$  under pressure, overwrapped with PVC (polyvinyl chloride) packaging material and stored at  $-18^{\circ}\text{C}$  for 12 months. Twelve 1-pound fillet blocks were stored at  $-40^{\circ}\text{C}$  as a reference for sensory evaluations.

### Product Evaluation

Three blocks each of filleted and minced spot were evaluated organoleptically, physically, and chemically after 0, 3, 6, and 12 months of storage ( $-18^{\circ}\text{C}$ ). Two fillet blocks stored at  $-40^{\circ}\text{C}$  were used as a reference sample for sensory comparison. Physical and chemical values are reported as an average of three analyses.

### Sensory Evaluation

Sticks ( $1.3 \times 7.6 \times 3$  cm) were cut from frozen fillet blocks, mince

blocks, and reference samples, then battered, breaded, and fried approximately  $1\frac{1}{2}$  minutes in vegetable oil at  $182^{\circ}\text{C}$ . The sticks were cooled, wrapped in aluminum foil, and frozen at  $-18^{\circ}\text{C}$ . They were removed from storage the next day, cooked approximately 15 minutes in an oven heated to  $204^{\circ}\text{C}$  and served to a 12-member taste panel.

The panel rated the samples for color, flavor, firmness, odor, and overall acceptability on a scale of 1-5. Sensory attributes were rated as: Color, 1 = white, 5 = dark; firmness, 1 = soft, 5 = firm; flavor, 1 = bland, 5 = strong; odor, 1 = mild, 5 = strong; and acceptability, 1 = acceptable, 5 = unacceptable).

The reference samples, used as the sensory control, were stored at  $-40^{\circ}\text{C}$  to minimize sensory changes due to storage and to be more nearly representative of seasonal sensory attributes of samples under evaluation.

### Physical Measurements

Color values (L = lightness, a = redness, b = yellowness) were determined on a  $6.5\text{ cm}^2$  portion from each block, using a Hunter-lab<sup>5</sup> color and color-difference meter. Two values were obtained from each of two sides of the portion by rotating the portion  $90^{\circ}$  after the first reading. The color value for each portion is, therefore, an average of four readings.

Shear force (texture) values were obtained on 110 g portions of each block at a product temperature of  $6^{\circ}\text{C}$ , using the Kramer Shear press (Kramer and Twigg, 1966). Values are reported as total pounds of shear force.

### Chemical Analyses

Samples used for thiobarbituric acid (TBA) analyses were cut from near the center of each frozen block so as to be truly representative of the total exposed area; samples were homogenized only after addition to the extracting solution. Samples for the remaining

<sup>3</sup>Decker, C. D., S. K. Holt, and D. B. Westering. 1980. Ingredients for product development. 4 gelling proteins. Presented at the Third National Technical Seminar on Mechanical Recovery and Utilization of Fish, December 1980, Raleigh, N.C.: Ralston Purina Company, St. Louis, Mo.

<sup>4</sup>Thrash, B. 1980. Surimi production in the United States. Presented at the Third National Technical Seminar on Mechanical Recovery and Utilization of Fish, December 1980, Raleigh, N.C.: Production Manager, Nichibei Fisheries, Inc., Bayou LaBatre, Ala.

<sup>5</sup>Mention of trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

chemical analyses were passed through a meat grinder three times to obtain a homogeneous mixture. Ground samples for proximate composition, amino acid, and fatty acid analyses were placed separately in vapor-proof containers, frozen, and held at  $-40^{\circ}\text{C}$  until analyzed. Proximate analyses and pH determinations were conducted according to the AOAC method (AOAC, 1975). Fat was measured according to the Bligh-Dyer method as modified by Smith et al. (1964). TBA determinations were performed as a measure of oxidative rancidity, using Vyncke's direct extraction method (Vyncke, 1972), and results are expressed as mg malonaldehyde (MA)/kg tissue. Total volatile nitrogen (TVN) and trimethylamine-nitrogen (TMA-N) were determined as described by Cobb et al. (1973). Fatty acid profiles were obtained by gas chromatography on methyl esters of the extracted lipids (Gauglitz and Lehman, 1963).

Samples for amino acid analysis were prepared initially by drying duplicate samples 2 days in a Virtis model FFD-15-W5 freeze dryer. Moisture-free samples were then extracted with petroleum ether for 8 hours in a Soxhlet extraction apparatus to remove the lipids. The dry, lipid-free samples were ground to pass a 40-mesh screen in a Cyclo-Tech sample grinding mill. Crude protein ( $\text{N} \times 6.25$ ) was determined on the ground samples by the Kjeldahl method (AOAC, 1975). Amino acids, other than methionine, cystine, and tryptophan, were determined by the method of Spackman et al. (1958). Ground samples were weighed into hydrolysis tubes containing 6 N hydrochloric acid, evacuated, sealed, and hydrolyzed 22 hours with rotation in a  $110^{\circ}\text{C}$  forced air oven. Contents of each tube were evaporated to dryness on a Buchler rotary evaporator and diluted to volume with sodium citrate buffer. The samples were then analyzed for total amino acid content on a Dionex Amino Acid/Peptide Analyzer Kit, Model MBN/SS. Methionine and cystine content were determined with a performic acid oxidation pretreatment

Table 1.—The mean and range of values for proximate composition of mince and fillet blocks of spot stored 12 months at  $-18^{\circ}\text{C}$ .

Month and year harvested	Product form	Proximate composition (%)					
		Mean/range	Moisture	Protein	Fat	Ash	NPN
May 1979	Mince	Mean	75.33	17.25	6.44	0.86	0.02
		Range	73.38-76.09	16.70-18.56	5.12- 7.36	0.82-0.89	0.02-0.03
	Fillet	Mean	74.25	18.50	6.73	0.89	0.03
		Range	72.94-75.20	18.08-19.64	6.16- 7.81	0.86-0.93	0.02-0.03
July 1979	Mince	Mean	72.36	18.35	9.29	1.03	0.02
		Range	71.76-72.73	17.23-19.24	8.34-10.06	0.97-1.09	0.01-0.03
	Fillet	Mean	72.64	18.63	8.69	1.04	0.03
		Range	71.74-73.32	17.68-20.28	8.11- 9.84	0.99-1.12	0.02-0.04
October 1979	Mince	Mean	74.47	19.56	5.45	1.17	0.03
		Range	73.84-74.99	18.76-20.49	4.96- 5.71	1.04-1.26	0.02-0.04
	Fillet	Mean	73.34	19.73	6.51	1.09	0.04
		Range	72.65-74.42	19.30-20.54	5.50- 7.57	1.04-1.13	0.02-0.04
November 1979	Mince	Mean	76.55	19.04	4.31	1.11	0.03
		Range	76.10-77.22	18.45-19.76	4.08- 4.46	1.06-1.16	0.02-0.06
	Fillet	Mean	76.94	19.14	3.84	1.00	0.04
		Range	76.50-77.44	18.61-19.64	3.44- 4.25	0.93-1.06	0.02-0.07
February 1980	Mince	Mean	82.36	17.27	0.72	1.08	0.03
		Range	81.25-83.75	16.75-17.71	0.49- 0.85	1.04-1.16	0.02-0.04
	Fillet	Mean	82.04	17.79	0.60	1.04	0.03
		Range	81.29-83.88	17.20-19.10	0.37- 0.71	1.00-1.10	0.01-0.04

prior to normal hydrolysis as described above and according to the method of Moore (1963). Tryptophan content was determined by hydrolysis as described above, except that 4 N methane-sulfonic acid containing 0.2 percent 3-(2 aminoethyl) indole was substituted for the 6 N hydrochloric acid. These samples were then chromatographed on the basic column of a Phoenix Amino Acid analyzer, Model K-8000 VG.

## Results and Discussion

Processing yields for spot were 29 percent for hand-processed fillets and 41 percent for the minced flesh.

The proximate composition of mince and fillet blocks is presented in Table 1. The mean and range of values are shown for the 12-month storage period. An inverse relationship exists between the moisture and fat content of seasonally harvested samples, i.e., when the moisture was highest, the fat content was lowest. The fat content peaked in July and dropped to a low in February. Overall, the protein content peaked in October and dropped to a low in May. Both fat and protein content were lowest during the post-spawning period (February-May). Dawson (1958) reported that spawning occurs during the winter, usually

reaching its peak from December to February. The ash content was lowest in May samples and about equal in other monthly samples. The NPN (nonprotein nitrogen) content was low and varied little for all samples. Values for all proximate composition factors did not vary appreciably during storage.

The pH and shear values for mince and fillet blocks are shown in Table 2. The pH of spot harvested throughout the year did not change significantly. The lowest values were obtained in October and November just prior to the spawning season. The pH decreased slightly at 12 months of storage for both product forms.

The shear values for the minced form remained relatively stable throughout the year, except the February sample was inexplicably about double that of the others and the October sample about one-half that of the others. The values for fillets increased progressively from May 1979 through February 1980, possibly reflecting a physiological change in the muscle tissue during the life cycle and spawning period. The shear values for both forms increased during storage, indicating an increase in firmness of the flesh. The lower values for the mince, as compared with fillets, were

Table 2.—The pH, shear, TVN, TMA-N, and TBA values of mince and fillet blocks of spot stored 12 months at -18°C.

Month and year harvested	Product form	Months in storage															
		pH				Shear force (lb.)				TVN (mg N/100 g)				TMA-N (mg N/100 g)			
		0	3	6	12	0	3	6	12	0	3	6	12	0	3	6	12
May 1979	Mince	6.89	6.88	6.75	6.76	64	65	80	82	12.5	10.3	11.3	10.2	2.1	1.9	0.8	1.0
	Fillet	6.88	6.84	6.70	6.70	35	138	112	218	16.7	10.9	11.3	12.3	3.3	1.6	1.2	1.6
July 1979	Mince	6.91	6.76	6.68	6.57	69	71	77	83	8.7	9.4	10.7	8.4	0	1.2	1.0	1.0
	Fillet	6.92	6.76	6.56	6.51	167	283	311	343	8.0	8.7	11.3	8.8	0	1.3	1.0	1.0
October 1979	Mince	6.67	6.59	6.61	6.39	38	63	84	88	10.5	13.0	11.5	13.3	0	0	0	0
	Fillet	6.67	6.64	6.62	6.44	281	356	470	353	11.2	12.0	10.4	12.0	0	0	0	0
November 1979	Mince	6.71	6.73	6.71	6.48	67	100	93	105	9.6	10.0	10.1	14.3	1.3	1.7	0	1.8
	Fillet	6.66	6.75	6.71	6.45	434	398	532	343	10.3	9.7	9.3	13.8	1.3	1.8	0	2.1
February 1980	Mince	6.98	6.97	6.89	6.76	124	116	142	113	8.6	8.1	9.1	11.4	2.0	0	0	2.3
	Fillet	7.16	6.95	6.95	6.71	622	886	860	850	7.9	7.4	8.3	10.8	1.9	0	0	2.2

due to the loss of tissue integrity during mincing.

The TVN, TMA-N, and TBA values are also shown in Table 2. TVN values of the seasonal harvest fluctuated minimally and highest values were obtained from May samples. Generally, values increased only slightly during storage for both product forms and the increase may be due to sample variability rather than real increases. Significant increases during storage were not expected since freezing immobilizes most proteolytic enzymes. An increase in TVN content indicates the occurrence of proteolysis, resulting from the activity of proteolytic enzymes. The primary concern with frozen fish, however, is the prevention of oxidative rancidity, dehydration, and textural changes. The slight increase in TVN did not correspond with the slight decrease in pH, but again these changes may be due to sample variations and not real changes.

TMA-N values for both product forms were relatively low at 0-months of storage, indicating minimal pre-processing spoilage due to bacterial activity. Castell et al. (1974) stated that measurements of TMA-N are useful in estimating the quality of frozen, stored gadoid fillets, and that the TMA-N value indicates the extent of microbial spoilage before the muscle was frozen. TMA-N values remained relatively unchanged during storage.

TBA values for seasonally harvested fish varied at 0-storage time. The values peaked in July (midway be-

Table 3.—Color values of mince and fillet blocks of spot stored 12 months at -18°C.

Month and year harvested	Product form	Months in storage and L, a, and b values											
		0			3			6			12		
		L	a	b	L	a	b	L	a	b	L	a	b
May 1979	Mince	47.5	2.5	8.4	50.3	1.9	8.8	50.1	3.2	8.8	48.7	2.6	9.8
	Fillet	51.7	2.5	9.2	54.9	2.7	9.5	53.9	3.4	9.6	51.9	2.4	10.2
July 1979	Mince	51.6	5.9	8.5	47.9	4.3	9.9	48.7	3.6	9.6	50.4	-0.2	10.8
	Fillet	54.6	4.5	8.0	49.6	4.3	9.4	52.2	3.3	9.4	51.7	0.5	10.4
Oct. 1979	Mince	46.7	7.4	8.6	45.5	4.9	8.9	45.1	4.2	9.3	44.9	3.2	9.8
	Fillet	52.7	4.9	8.0	50.3	4.1	9.5	51.9	3.0	8.9	51.5	2.6	9.7
Nov. 1979	Mince	42.7	8.0	8.4	42.7	5.4	9.7	40.5	5.4	9.0	42.1	3.5	9.2
	Fillet	50.1	6.8	8.8	49.7	5.2	10.5	48.8	4.3	10.0	49.2	3.4	9.7
Feb. 1980	Mince	36.9	7.5	8.6	34.5	6.2	8.1	36.8	6.2	6.4	34.4	5.4	7.9
	Fillet	41.7	6.8	8.8	42.7	6.1	8.6	40.3	7.0	6.8	44.0	4.1	8.4

tween spawning seasons) and decreased to a minimum in November and February (peak of spawning). There is good correlation between increased TBA values and high fat content (Table 1). In general, TBA values increased with storage and peaked at 6 months except the May samples which peaked at 12 months.

Values for the minced form were slightly higher than the filleted form, for stored samples, possibly due to oxidation of the lipids as a result of the incorporation of oxygen into the flesh during the mincing process. Metal ions from the mincing equipment may have enhanced this effect (Lee and Toledo, 1977; Castell, 1971; Castell and Spears, 1968). The moderate increase in values indicated that some rancidity occurred during storage. However, rancid flavors or odors, which may have been masked by the strong fishy

flavor and odor, and flavor of the batter and breading, were not reported by the sensory panel.

The color values for mince and fillet blocks are presented in Table 3. The L-values (lightness) for seasonally harvested samples (mince and fillets) varied moderately and followed similar changes as the fat content and TBA values, i.e. highest TBA, fat, and L-values in July and lowest values in February. L-values for mince blocks were lower than fillet blocks due to uniform dispersement of the dark flesh (and residual blood) during the mincing process. The a-values (redness) were lowest for May samples (about one-half that of the others) and highest for November and February samples (0-months of storage). Values for May samples remained stable through 12 months of storage; July samples decreased significantly at 12 months and

all other samples decreased rather consistently during storage. The b-values (yellow) remained relatively unchanged for all samples throughout the storage period. Overall, the color of minced and filleted spot appears to be only slightly affected by season of harvest and frozen storage.

Sensory scores for acceptability, color, flavor, firmness, and odor of spot, harvested seasonally and stored 12 months, are shown in Figures 1-5, respectively. Generally, the minced form was less acceptable to the panel for all months of harvest (and storage)

due to the color, flavor, and odor of the mince but primarily due to the dark color of the flesh. The color of minced fish flesh can be improved by washing with cold water as shown by Rasekh et al. (1980). Firmness scores varied the least (seasonally and during storage) among product forms and the reference sample was preferred (in most attributes tested) over the minced and filleted forms held at  $-18^{\circ}\text{C}$ . Season of harvest and time in storage had little affect on sensory judgement of both product forms.

The concentration of essential amino

acids of minced and filleted spot is shown in Table 4 and expressed as a percentage of the protein content. Amino acid values were obtained only at 0-months of storage. Monthly values varied little between the mince and fillet forms except for histidine, which was about 23 percent lower for the fillet form of the February sample. Appreciable seasonal fluctuations are apparent only for histidine (February: fillet), glutamic acid (February: mince), and taurine (October: mince). All values, however, are comparable to those reported by Sidwell (1981).

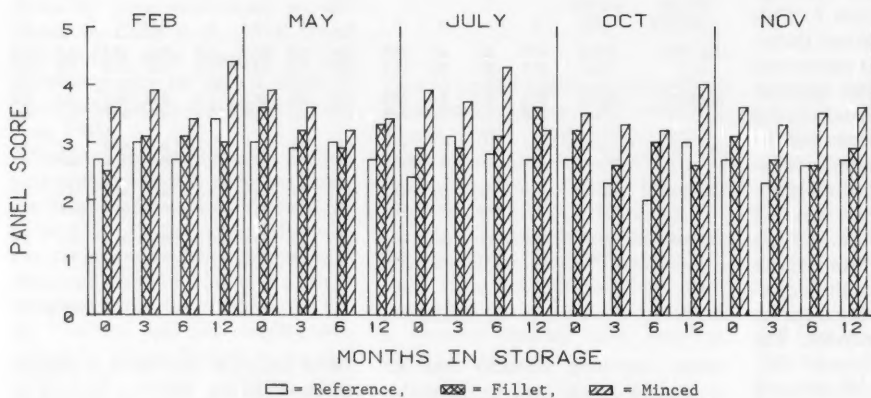


Figure 1.—Sensory panel scores for overall acceptability of minced and filleted spot harvested seasonally and stored 12 months at  $-18^{\circ}\text{C}$ . 1 = acceptable; 5 = unacceptable.

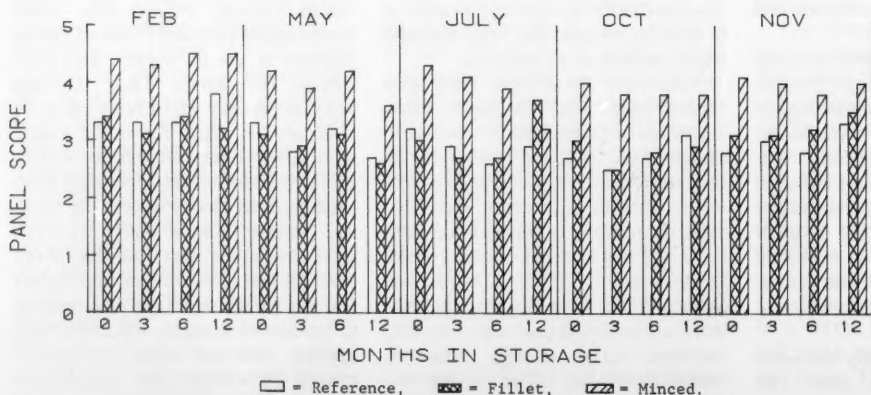


Figure 2.—Sensory panel scores for color of minced and filleted spot harvested seasonally and stored 12 months at  $-18^{\circ}\text{C}$ . 1 = white; 5 = dark.

Figure 3.—Sensory panel scores for flavor of minced and filleted spot harvested seasonally and stored 12 months at  $-18^{\circ}\text{C}$ . 1 = bland; 5 = strong.

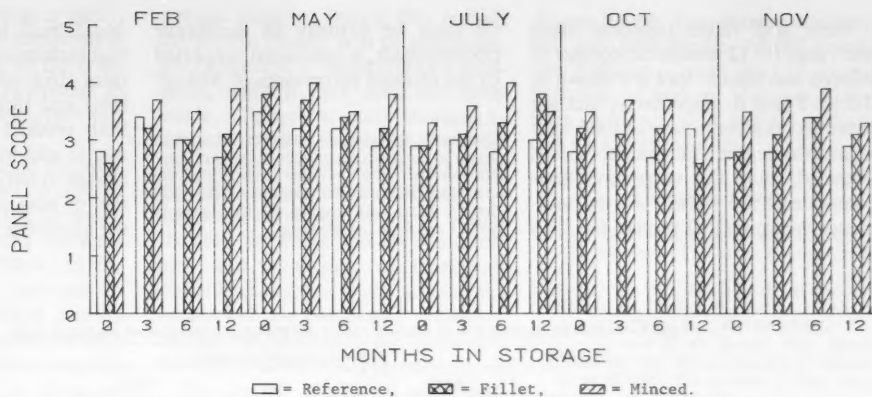


Figure 4.—Sensory panel scores for firmness of minced and filleted spot harvested seasonally and stored 12 months at  $-18^{\circ}\text{C}$ . 1 = soft; 5 = firm.

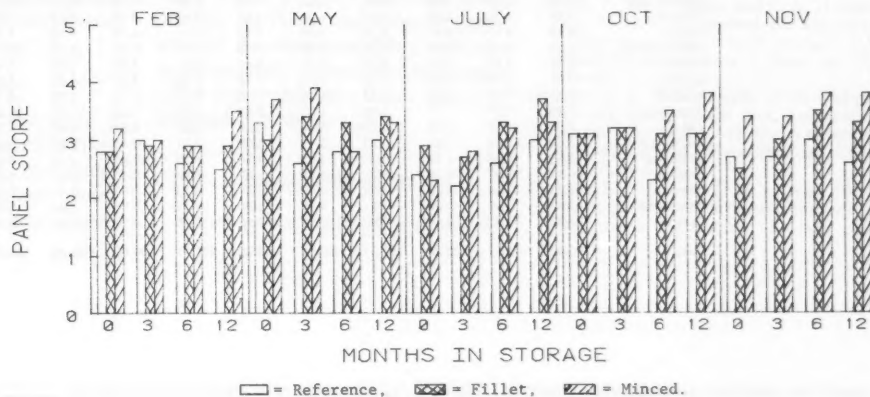
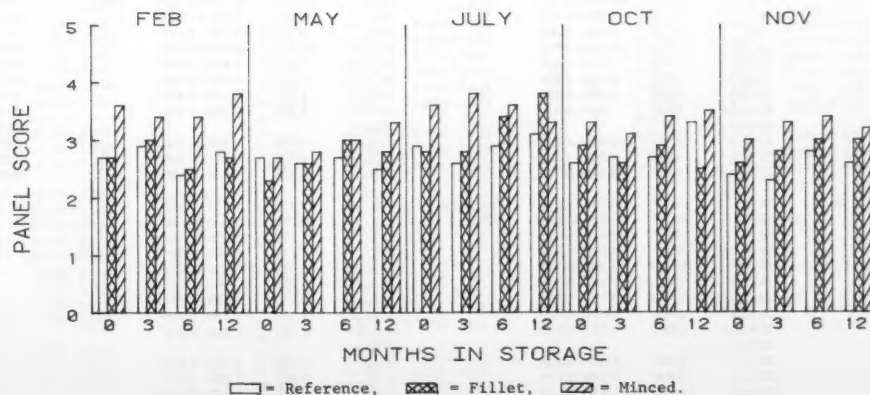


Figure 5.—Sensory panel scores for odor of minced and filleted spot harvested seasonally and stored 12 months at  $-18^{\circ}\text{C}$ . 1 = mild; 5 = strong.



Fatty acid values (seasonal mean and range for 12 months of storage) of minced and filleted spot are shown in Tables 5 and 6, respectively, and are expressed as a percentage of total fatty acids. Although a complete profile was obtained, only the more important components are shown. At the mid-winter minimum (0.7 percent fat), this

fat must be virtually all membrane phospholipids, a conclusion supported by the elevated percentages of 20:4 $\omega$ 6<sup>a</sup>

<sup>a</sup>Notation indicates the number of carbon atoms in the molecule and the number of double bonds. The number following the  $\omega$ -symbol indicates the position of the final double bond with respect to the terminal methyl group of the molecule.

and 22:6 $\omega$ 3, both of which are important membrane fatty acids. Both saturates (16:0 and 18:0) and monoenes (16:1 and 18:1) declined seasonally in both product forms, from mid-summer to mid-winter. This may be a real change in fatty acid composition of the fish or may simply be a reflection of the increasing percentages of the poly-

Table 4.—Percent composition of amino acids of minced and filleted spot harvested on a seasonal basis.

Amino acid	Product form/month of harvest									
	Fillet					Mince				
	May	July	Oct.	Nov.	Feb.	May	July	Oct.	Nov.	Feb.
Tryptophan	1.07	1.22	1.07	1.21	0.96	1.13	1.13	1.06	1.05	1.05
Lysine	9.71	9.70	10.00	9.99	9.26	9.77	9.79	9.88	9.53	9.98
Histidine	2.20	2.25	2.34	2.10	1.61	2.42	2.54	1.99	2.05	2.10
Ammonia	1.19	1.01	1.09	1.00	1.14	1.12	1.06	1.14	0.90	1.02
Arginine	6.41	6.42	6.39	6.47	6.66	6.53	6.47	6.53	6.23	6.70
Aspartic acid	10.15	10.27	10.22	10.30	10.38	10.28	10.06	10.05	10.22	10.27
Threonine	4.65	4.75	4.64	4.63	4.76	4.57	4.63	4.58	4.63	4.64
Serine	4.18	4.17	4.12	4.12	4.22	4.15	4.11	4.18	4.19	4.11
Glutamic acid	15.68	15.40	15.56	15.84	16.36	15.72	15.12	15.49	15.93	16.57
Proline	3.40	3.40	3.45	3.34	3.44	3.45	3.61	3.80	3.69	3.10
Glycine	4.95	5.14	5.05	4.82	4.73	4.76	5.38	4.97	4.89	4.21
Alanine	6.11	6.40	6.22	6.34	6.46	6.05	6.34	6.18	6.28	6.16
Cystine	1.43	1.26	1.11	1.06	1.02	0.87	1.20	1.03	1.37	0.96
Valine	4.64	4.76	4.62	4.79	4.94	4.55	4.83	4.81	4.90	4.75
Methionine	3.56	3.39	3.51	3.53	3.11	3.06	3.21	3.45	3.57	3.40
Isoleucine	4.50	4.56	4.54	4.51	4.63	4.58	4.38	4.62	4.42	4.64
Leucine	8.41	8.37	8.35	8.21	8.55	8.37	8.22	8.40	8.40	8.46
Tyrosine	3.31	3.29	3.22	3.22	3.49	3.77	3.13	3.31	3.37	3.34
Phenylalanine	3.60	3.48	3.65	3.61	3.36	3.90	3.82	3.77	3.42	3.61
Taurine	0.87	0.77	0.85	0.92	0.93	0.94	0.98	0.75	0.94	0.94
Total	100.02	100.01	100.00	100.01	100.01	99.99	100.01	99.99	99.98	100.01

Table 5.—The mean and range of values for the fatty acid profile (weight percent composition) of minced spot harvested on a seasonal basis and stored at -18°C for 12 months.

Date harvested	Fatty acid	Weight percent		Date harvested	Fatty acid	Weight percent		Date harvested	Fatty acid	Weight percent	
		Mean	Range			Mean	Range			Mean	Range
May 1979	14:0	2.539	2.512- 2.576	October 1979	14:0	2.528	2.252- 2.943	February 1980	14:0	1.816	1.566- 2.375
	16:0	25.617	24.686-26.735		16:0	23.496	22.045-24.162		16:0	19.409	18.165-20.745
	16:1	12.482	12.306-12.821		16:1	10.611	9.801-11.671		16:1	6.126	5.368- 7.472
	18:0	5.756	4.696- 6.364		18:0	6.724	6.163- 7.111		18:0	8.571	6.871- 9.614
	18:1ω9	21.890	21.123-22.958		18:1ω9	20.847	20.279-21.434		18:1ω9	15.406	15.026-15.753
	18:2ω6	1.434	1.310- 1.552		18:2ω6	1.089	0.867- 1.670		18:2ω6	1.023	0.654- 1.336
	18:3ω3	0.797	0.746- 0.904		18:3ω3	0.613	0.294- 0.998		18:3ω3	0.600	0.365- 0.788
	18:4ω3	2.834	2.529- 3.206		18:4ω3	4.945	4.147- 5.479		18:4ω3	3.312	2.835- 3.802
	20:4ω6+	1.224	1.021- 1.577		20:4ω6+	2.466	2.203- 2.741		20:4ω6+	4.785	4.306- 5.212
	20:3ω3				20:3ω3				20:3ω3		
	20:5ω3	2.751	2.490- 2.999		20:5ω3	4.710	4.321- 5.314		20:5ω3	6.123	5.566- 7.220
	22:5ω3	1.250	1.064- 1.424		22:5ω3	2.527	2.267- 2.685		22:5ω3	4.119	3.674- 4.382
	22:6ω3	9.207	8.466-10.071		22:6ω3	5.826	5.434- 6.595		22:6ω3	15.348	14.217-16.568
July 1979	14:0	4.017	3.287- 5.395	November 1979	14:0	3.169	2.917- 3.578				
	16:0	24.377	23.931-24.828		16:0	23.397	21.810-24.940				
	16:1	13.814	12.448-16.475		16:1	11.198	10.598-12.110				
	18:0	5.921	4.332- 6.994		18:0	6.719	6.161- 7.294				
	18:1ω9	20.429	18.606-20.753		18:1ω9	20.690	19.651-22.023				
	18:2ω6	0.551	0.478- 0.612		18:2ω6	0.750	0.504- 1.353				
	18:3ω3	0.453	0.227- 0.844		18:3ω3	0.540	0.283- 0.866				
	18:4ω3	2.460	1.075- 4.775		18:4ω3	5.309	4.720- 5.748				
	20:4ω6+	2.052	1.747- 2.244		20:4ω6+	2.561	2.408- 2.972				
	20:3ω3				20:3ω3						
	20:5ω3	6.527	5.527- 8.509		20:5ω3	4.458	3.720- 4.928				
	22:5ω3	2.304	2.129- 2.421		22:5ω3	2.858	2.520- 3.027				
	22:6ω3	4.785	4.453- 5.318		22:6ω3	5.989	5.307- 6.715				

unsaturates, which is, almost certainly, a real seasonal change in composition since the polyunsaturates of the cellular lipids become more prominent in the fatty acid profile as the depot fats are utilized by the fish.

No significant decreases in the polyunsaturates were apparent in any of the groups of fillets over the 12 month storage period, suggesting minimal lipid oxidation in the fillets. In the minced fish, significant decreases in 20:4 $\omega$ 6, 20:5 $\omega$ 3, and 22:6 $\omega$ 3 over 12 months of storage were observed only in those samples from fish harvested in February 1980. This may be due to the absence of natural antioxidants, such as the tocopherols, which are derived from food and carried in the depot fat, but it is equally possible that mincing introduced atmospheric oxygen which oxidized the highly labile polyunsaturates.

### Conclusions

Based on the results of this study, it is concluded that spot harvested from early fall (October) to mid-winter (February) contain optimum nutritional values and exhibit good frozen

storage stability. During this period, the protein content is at its maximum, the fat content is decreasing to a minimum, and the fatty acids are fairly stable. Changes in other characteristics, such as the functional properties and chemical quality indices, are minimal during this period. Although the suggested harvesting period is during the early spawning and spawning season, and at a time of maximum physiological stress of the animal, the results indicate the overall utilization quality characteristics are maximum between October and February.

The overall quality of spot, particularly the minced form, could be significantly enhanced through the use of physical and chemical treatments. Washing the minced flesh with cold water would improve the color (and possibly the flavor and texture); treatment of the mince and fillets with antioxidants may minimize oxidative rancidity even when the lipids are at a minimal level in the fish.

### Acknowledgments

The author expresses gratitude to

Jeanne Joseph, Tom Brown, Jim Bonnet, and Beth Beville, NMFS Southeast Fisheries Center, and to Foster Wardlaw, Clemson University, for their assistance with sample analyses and data interpretation.

### Literature Cited

- AOAC. 1975. Official methods of analysis, 12th ed. Assoc. Off. Anal. Chem., Wash. D.C.
- Castell, C. H. 1971. Metal-catalyzed lipid oxidation and changes of proteins in fish. J. Am. Oil Chem. Soc. 48(11):645-649.
- \_\_\_\_\_, and D. M. Spears. 1968. Heavy metal ions and the development of rancidity in blended fish muscle. J. Fish. Res. Board Can. 25:639-656.
- \_\_\_\_\_, B. Smith, and W. J. Dyer. 1974. Simultaneous measurements of trimethylamine and dimethylamine in fish and their use for estimating quality of frozen-stored gadoid fillets. J. Fish. Res. Board Can. 31:383-389.
- Cobb, B. F., III, I. Alaniz, and C. A. Thompson, Jr. 1973. Biochemical and microbial studies on shrimp: Volatile nitrogen and amino nitrogen analysis. J. Food Sci. 38: 431-436.
- Dawson, C. E. 1958. A study of the biology and life history of the spot, *Leiostomus xanthurus* Lacepede, with special reference to South Carolina. Bears Bluff Lab. Contrib. 28, 48 p.
- Gauglitz, E. J., Jr., and L. W. Lehman. 1963. The preparation of alkyl esters from highly unsaturated triglycerides. J. Am. Oil

Table 6.—The mean and range of values for the fatty acid profile (weight percent composition) of filleted spot harvested on a seasonal basis and stored at  $-18^{\circ}\text{C}$  for 12 months.

Date harvested	Fatty acid	Weight percent		Date harvested	Fatty acid	Weight percent		Date harvested	Fatty acid	Weight percent	
		Mean	Range			Mean	Range			Mean	Range
May 1979	14:0	2.527	2.452-2.630	October 1979	14:0	2.569	2.356-2.824	February 1980	14:0	1.388	0.717-2.481
	16:0	25.677	24.834-26.563		16:0	23.594	22.569-24.670		16:0	19.247	18.746-20.316
	16:1	12.246	11.585-12.509		16:1	11.158	10.720-12.048		16:1	5.232	3.408-8.772
	18:0	6.044	5.559-6.327		18:0	6.767	6.402-6.950		18:0	9.279	6.740-10.372
	18:1 $\omega$ 9	22.091	21.501-22.519		18:1 $\omega$ 9	20.468	19.404-21.305		18:1 $\omega$ 9	13.447	11.227-15.665
	18:2 $\omega$ 6	1.402	1.218-1.520		18:2 $\omega$ 6	1.059	0.770-1.657		18:2 $\omega$ 6	1.156	0.821-1.521
	18:3 $\omega$ 3	0.751	0.628-0.821		18:3 $\omega$ 3	0.619	0.243-0.944		18:3 $\omega$ 3	0.466	0.396-0.560
	18:4 $\omega$ 3	2.728	2.485-3.039		18:4 $\omega$ 3	5.143	4.376-5.856		18:4 $\omega$ 3	2.592	1.853-3.349
	20:4 $\omega$ 6+	1.051	0.963-1.131		20:4 $\omega$ 6+	2.562	2.253-2.873		20:4 $\omega$ 6+	5.579	4.910-6.578
	20:3 $\omega$ 3				20:3 $\omega$ 3				20:3 $\omega$ 3		
	20:5 $\omega$ 3	2.645	2.534-2.857		20:5 $\omega$ 3	4.557	4.467-4.742		20:5 $\omega$ 3	6.289	6.096-6.510
	22:5 $\omega$ 3	1.228	1.194-1.305		22:5 $\omega$ 3	2.389	2.193-2.602		22:5 $\omega$ 3	4.136	3.656-4.673
	22:6 $\omega$ 3	9.602	9.104-10.114		22:6 $\omega$ 3	6.019	5.706-6.327		22:6 $\omega$ 3	18.966	14.217-21.702
July 1979	14:0	3.275	3.275-4.139	November 1979	14:0	2.908	2.506-3.988				
	16:0	24.943	24.148-25.668		16:0	23.235	22.137-24.286				
	16:1	13.078	12.256-14.473		16:1	10.633	9.793-12.694				
	18:0	6.422	6.298-6.647		18:0	6.775	5.266-7.585				
	18:1 $\omega$ 9	21.098	20.707-21.626		18:1 $\omega$ 9	20.700	18.780-22.716				
	18:2 $\omega$ 6	0.537	0.494-0.558		18:2 $\omega$ 6	0.847	0.441-1.455				
	18:3 $\omega$ 3	0.299	0.162-0.757		18:3 $\omega$ 3	0.560	0.217-0.894				
	18:4 $\omega$ 3	2.532	1.795-4.045		18:4 $\omega$ 3	4.861	3.352-5.676				
	20:4 $\omega$ 6+	2.014	1.795-2.213		20:4 $\omega$ 6+	2.544	1.874-2.942				
	20:3 $\omega$ 3				20:3 $\omega$ 3						
	20:5 $\omega$ 3	6.083	5.435-6.587		20:5 $\omega$ 3	4.833	3.914-6.170				
	22:5 $\omega$ 3	2.272	2.034-2.405		22:5 $\omega$ 3	3.116	2.796-3.359				
	22:6 $\omega$ 3	5.156	4.619-5.824		22:6 $\omega$ 3	6.799	6.154-8.296				

- Chem. Soc. 40:197-198.
- Gutherz, E. J., G. M. Russell, A. F. Serra, and B. A. Rohr. 1975. Synopsis of the northern Gulf of Mexico industrial and foodfish industries. *Mar. Fish. Rev.* 37(7):1-11.
- Hildebrand, S. F., and L. E. Cable. 1930. Development and life history of fourteen teleostean fishes at Beaufort, N.C. U.S. Bur. Fish. Bull. 46:383-488.
- Kramer, A., and B. A. Twigg. 1966. Fundamentals of quality control for the food industry, 2nd ed. AVI Publ. Co., Westport, Conn., 541 p.
- Lee, C. M., and R. T. Toledo. 1977. Degradation of fish muscle during mechanical deboning and storage with emphasis on lipid oxidation. *J. Food Sci.* 42(6):1646-1649.
- Moore, S. 1963. On the determination of cystine as cystic acid. *J. Biol. Chem.* 238(1): 235-237.
- NMFS. 1981. Fisheries of the United States, 1980. U.S. Dep. Commer., NOAA, Natl. Mar. Fish. Serv., Curr. Fish. Stat. 8100, 132 p.
- Parker, J. C. 1971. The biology of the spot, *Leiostomus xanthurus* Lacepede, and Atlantic croaker, *Micropogon undulatus* (Linnaeus), in two Gulf of Mexico nursery areas. Sea Grant Publ. TAMU-SG-71-210, Texas A & M Univ., Coll. Stn., 161 p.
- Rasekh, J. G., M. E. Waters, and V. D. Sidwell. 1980. The effect of washing on the quality characteristics of minced fresh croaker, *Micropogon undulatus*, held in frozen storage. *Mar. Fish. Rev.* 42(11): 26-30.
- Sidwell, V. D. 1981. Chemical and nutritional composition of finfishes, whales, crustaceans, mollusks, and their products. NOAA Tech. Memo. NMFS F/SEC-11.
- Smith, P., Jr., M. E. Ambrose, and G. N. Knobl, Jr. 1964. Improved rapid method for determining the total lipid in fish meal. *Commer. Fish. Rev.* 26(7):1-5.
- Spackman, D. H., W. H. Stein, and S. Moore. 1958. Automatic recording apparatus for use in the chromatography of amino acids. *Anal. Chem.* 30:1190-1205.
- Vyncke, W. 1972. Direct determination of the thiobarbituric acid value in trichloroacetic acid extracts of fish as a measure of oxidative rancidity. *Fette. Seifen Anstrichmittel* Osland, Belgium 12:1084-1087.

## Regional Fishery Management Council Members Named

Twenty-three new members and nine incumbents have been appointed to vacancies on the nation's eight Regional Fishery Management Councils, John V. Byrne, Administrator of the National Oceanic and Atmospheric Administration, has announced. The appointments will run for 3 years, except as noted.

The Councils, established by the Fishery Conservation and Management Act of 1976, prepare management plans for fish stocks within their geographical areas. Council members are selected from lists of individuals submitted by the Governors of the constituent States of the Councils. The newly appointed members, listed by Council, are as follows.

**New England Council:** Lawrence P. Greenlaw, Jr., Manager, Stonington Lobster Cooperative, Stonington, Me.; James Costakes, General Manager, Seafood Producers Association, New Bedford, Mass.; Robert D. Smith, Liaison for Regulatory Affairs, Point Judith Fishermen's Cooperative, Narragansett, R.I.; and Lester B. Smith, former Director, National Wildlife Federation, Natick, Mass.

**Mid-Atlantic Council:** Barry T. Parker, Attorney, Mount Holly, N.J.; William J. Hargis, Jr., Professor of Marine Science, College of William and Mary, Virginia Institute of Marine Science, Gloucester Point, Va.; Raymond T. Richardson, Director of Public Relations, Seacoast Products, Inc., Port Monmouth, N.J.; and Robert L. Martin (2-year term), Attorney, Litkey, Lee, Martin, Grine & Green, Bellefonte, Pa.

**South Atlantic Council:** Marilyn M. Moreira, Co-owner, Paul Moreira

Shrimp Company, Inc., Brunswick, Ga.; Gregory S. McIntosh, Jr., President, MACENT, Inc., Ft. Lauderdale, Fla.

**Gulf of Mexico Council:** LeRoy E. Demarest, Seafood Industry Consultant, Kenner, La.; Alex M. Jernigan, Consulting Engineer, Post, Buckley, Schub, and Jernigan, Miami, Fla.; Walter M. Fondren, III, Investments, Houston, Tex.; and Sherman L. Muths, Jr., Attorney, Gulfport, Miss.

**Caribbean Council:** Roberto Moreno-Carreras, Attorney, Hato Rey, Puerto Rico; and John D. Woods (1-year term), Project Coordinator, Virgin Islands Port Authority, St. Thomas, Virgin Islands.

**Pacific Council:** Otto H. Teller, Retired Banker, Glen Ellen, Calif.; Alan L. Kelly, Manager, Kelly-Rudd Insurance, Inc., Portland, Oreg.; and Abel C. Galletti, Partner, Galletti Brothers Foods, Los Angeles, Calif.

**North Pacific Council:** Jeffrey R. Stephan, Manager United Fishermen's Marketing Association, Inc., Kodiak, Alaska; and Rudy A. Petersen, commercial fisherman, Seattle, Wash.

**Western Pacific Council:** Louis K. Agard, Jr., Owner, Marine Supply & Exchange, Honolulu, Hawaii; and Robert D. Smith, recreational fisherman, Tamuning, Guam.

Incumbents reappointed are as follows. **New England Council:** Patrick L. Carroll, III, Carroll Associates, Fairfield, Conn.

**Mid-Atlantic Council:** Barbara D. Stevenson, Commercial Fishing, Otanka, Inc., Dagsboro, Del.

**South Atlantic Council:** Allen F. Branch, recreational fisherman, Midway, Ga., and Melvin R. Daniels, Jr.,

State Senator, Elizabeth City, N.C.

**Gulf of Mexico Council:** Dayton M. Graham, President, Deep Sea Foods, Inc., Bayou La Batre, Ala.

**Caribbean Council:** Samuel E. Espinosa, President, Espinosa Fishing, Inc., St. Croix, Virgin Islands.

**Pacific Council:** Guy R. McMinds, Director, Quinalt Indian Office, Department of Natural Resources and Economic Development, Taholah, Wash.

**North Pacific Council:** James O. Campbell, President, Alaska Division, Spenard Builders Supply, Inc., Anchorage, Alaska.

**Western Pacific Council:** Peter E. Reid, Jr., Manager, G.H.C. Reid & Company, Inc., Pago Pago, American Samoa.

## Acid Rain Detected In Isolated Areas Globally

Acidity — some occurring naturally, some from manmade causes — has been found in rain in five isolated, widely separated areas, the National Oceanic and Atmospheric Administration (NOAA) has announced.

The Commerce Department agency said acid rain from manmade causes was found in St. Georges, Bermuda; and Poker Flat, Alaska, and from a mixture of natural and manmade causes, at San Carlos, Venezuela; Katherine, Australia; and Amsterdam Island in the Indian Ocean. James Galloway of the University of Virginia and Gene Likens of Cornell University are carrying out the project for NOAA.

These findings show that acid rain may be nearly worldwide in distribution. Previously, it was thought to occur primarily downwind of heavy industry where it is more acid than in remote areas. "If we are going to monitor and perhaps combat acid rain," said John Miller, deputy director of NOAA's Air Resources Laboratories, "we need to know its natural distribution over the earth."

Begun in 1979, the Global Precipitation Chemistry Project is trying to de-

termine how naturally acid the rain is in remote areas of the globe, and how much it is affected by long-range transport of sulfur and nitrogen from fossil fuel combustion. The preliminary results came from rain collected at sites

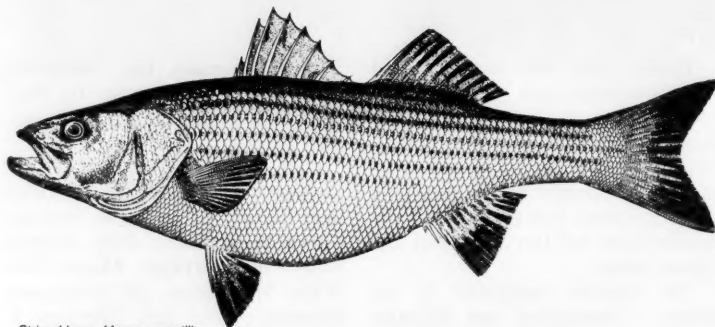
removed from volcanic influences (which increase acidity), at least 600 miles from any large industrial or urban area, and with annual precipitation of more than 20 inches.

The greatest acidity was found at the

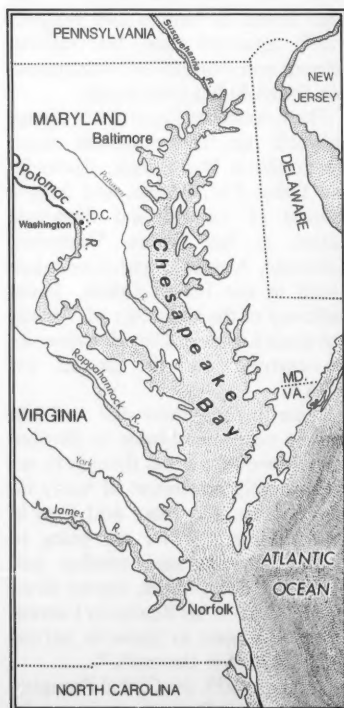
sites in Bermuda, Australia, and Venezuela, where the average pH value was 4.8. Amsterdam Island rain averaged a pH of 4.9, Poker Flat rain and snow, pH 5. A pH of 7 is neutral, and a pH of 5.6 or less is considered acid rain.

## Striped Bass Population Rising in Chesapeake Bay

Striped bass production in the Chesapeake Bay may be recovering dramatically from its all-time low in 1981, the National Oceanic and Atmospheric Administration has announced. Densities of inch-long fry in the Potomac and Rappahannock rivers, major striped bass nurseries for the Bay, are from 100 to 1,000 times greater than last year, according to F. Douglas Martin of the University of



Striped bass, *Morone saxatilis*



Maryland and John Olney of the Virginia Institute of Marine Sciences.

Periodic large increases of fish produced in a single year—dominant year classes—have been a mainstay of the coastal striped fishery since the 1930's. The last such year-class, largest in 30 years, occurred in 1970 and brought record catches in 1973. Early indications are that 1982 may be another period which will generate large catches in 2-3 years, but scientists will know more accurately when juvenile striper surveys are completed.

Martin and Olney believe the increase may have been caused by ideal water temperatures, stable freshwater flows into the Bay, and an abundant food supply. The decline in the striper population may be a result of overfishing, habitat deterioration, pollutants, or industrial development, scientists say.

The researchers are associated with the Emergency Striped Bass Study, jointly sponsored by NOAA's National Marine Fisheries Service and the Interior Department's U.S. Fish and Wildlife Service. The study has moni-

tored striped bass production in North Carolina, Virginia, Maryland, New Jersey, and New York, since 1980. Waters in these states are major sources of migratory coastal populations of stripers caught from Maine to North Carolina. Findings of the study were presented at a public meeting of the Striped Bass Planning and Coordination Group in Washington last summer.

## Volcanic Dust Blocks Sea Surface Temperature Data

A thin cloud of dust from a Mexican volcano has prevented satellite measurement of sea surface temperatures in a wide, globe-girdling band but has not reduced weather forecasting capability, the National Oceanic and Atmospheric Administration (NOAA) reports. Dust from El Chichon extends from lat. 10° to 30° N, roughly from the Panama Canal to Charleston, S.C., or from Cebu, in the Philippines, to Yokohama, Japan.

Sea surface temperatures are used by oceanographers and by meteorologists in weather forecasting, climatology, and research. NOAA's National Weather Service explained that sea surface temperatures are also measured by ships and buoys and there is no evidence thus far of loss of forecast accuracy.

The El Chichon dust cloud, although very thin, drifted upward into the stratosphere and became chilled by

the stratospheric temperature, said Alan E. Strong, an oceanographer with NOAA's National Earth Satellite Service. The NOAA satellite looking down on the earth measures radiation from the sea surface and translates the measurements into temperatures, which are sent back to NOAA land stations. Ordinary water vapor clouds prevent the satellite from "seeing" the sea surface, Strong explained, and the wispy El Chichon dust, at its high alti-

tude, was so cold that it also intercepted and contaminated the heat radiation measurements.

NOAA scientists are now working to separate the effects of the El Chichon dust, so that they can both monitor the cloud from El Chichon over the next few years as it gradually disperses, and also devise a correction factor that will enable them again to provide accurate sea surface temperature measurements from the affected latitudes.

## **Marianas Cruises Locate Fish Resources, New Bank**

Two of three 40-day fisheries cruises in the Marianas Archipelago last summer have helped to identify and assess the fishery resources in areas of interest to the United States (including Guam and the Marianas Islands), according to Richard S. Shomura, Director of the Southwest Fisheries Center's Honolulu Laboratory.

Data were collected on snappers and groupers, deepwater shrimps, and akule at selected sites in the Marianas Archipelago to estimate the distribution, abundance, and sustainable yield of these fishery resources, reports Jeffrey J. Polovina, project leader and chief scientist on the first cruise. Bathymetric surveys south of Guam also documented a new bank just southwest of Santa Rosa Reef and about 35 n.mi. southwest of Guam. It is slightly larger than either Galvez Banks or Santa Rosa Reef, and its shallowest point is approximately 11 fathoms (66 feet).

During the biological portion of the cruise, bottom fishes, deepwater shrimps, and akule were sampled at Esmeralda Bank, Anatahan Island, Sarigan Island, Pagan Island, Tinian Island, Aguijan Island, Galvez Banks, Santa Rosa Reef, and the newly charted bank. The bottom fish catch rate for the entire cruise averaged 3.1 fish per line hour with the best daily catch rate of 6.4 fish per line hour obtained at Aguijan Island. The predominant species caught were gindai, yellow-

eyed opakapaka, and yellow-tailed kalekale. The catch rate for deepwater shrimps sampled at 350 fathoms (2,100 feet) for the entire cruise averaged 4.2 pounds per trap with the best catch rates of 7.6 pounds obtained at the Island of Anatahan. Akule were found at many of the islands and banks and samples were collected to estimate growth and mortality parameters.

In addition to NMFS scientists, three researchers from the University of Guam's Marine Laboratory and one staff member of the Department of Natural Resources, Commonwealth of the Northern Marianas, participated in the first cruise.

On the second 6-week cruise, scientists visited nine islands/banks, including stops at Guam, Farallon de Medinilla, Guguan, Alamagan, Pagan, and Agrihan Islands and Esmeralda, Arakane, and 38-Fathom Banks. Catches of bottom fish, including fishes of the deep-water snapper-grouper community, were best at Pagan and the other more northerly islands (Alamagan, Guguan, and Agrihan), all of which are volcanic and composed of basalt.

Catch rates around Guam were poor, amounting to only 15 percent of those farther north, according to Stephen Ralston, chief scientist. Overall, some 30 species of bottom fish were landed in 33 days of fishing, with an overall catch rate of 3.5 fish landed per line-hour of fishing. Catches were composed largely of snappers including gindai (50 percent of the total), yellow-tailed kalekale (18 percent), yellow-eyed opakapaka (7 percent), ehú (4 percent), and pink opakapaka

(3 percent). Another 5 percent of the catch was black ulua.

Catches of deepwater shrimp, composed mainly of the highly desirable *Heterocarpus laevis* and *H. longirostris*, were also very good. Four strings of five traps each were set overnight on 24 occasions and averaged 1.6 kg of shrimp per trap each day. Yields were best at Arakane Reef and Guguan Island which produced average daily catches as high as 5.73 and 5.17 kg per trap-night. As with bottomfish, the shrimp resources around Guam appeared to be substantially less than elsewhere.

Mackerel scad or akule was also sampled and over 1,600 were handlined during the cruise, mainly from Agrihan, Alamagan, Farallon de Medinilla, and Arakane Reef. Of these, 350 were tagged and released at Agrihan and 150 at Arakane Reef. Ralston reported that akule resources in the Marianas appeared to be substantial and could provide live bait for tuna fishing operations as well as excellent food for human consumption.

Bathymetric surveys of some of the lesser known fishing banks in the region, including Rota Bank and Farallon de Medinilla, were conducted and cooperative investigations with University of Guam researchers on zooplankton and mesopelagic fishes and shrimps were performed. In addition, an observer for the Commonwealth of the Northern Mariana Islands participated in the latter half of the trip. The vessel used in both cruises was the *Townsend Cromwell*, commanded by Robert C. Roush.

## Italians Enact New Fishery Development Plan

The Italian Parliament passed into law a fisheries development plan on 17 February 1982. The new plan, which required 3 years to develop, has a projected budget of about \$50 million to be spent by 1985. The plan has the following three objectives:

- 1) Promotion of scientific research and the technological development of marine fisheries and aquaculture,
- 2) Creation of fishery cooperatives for the harvesting, processing, distribution, and marketing of fishery resources, and
- 3) Modernization of the Italian fishing fleet and shore processing plants.

### New Fisheries Institute

To accomplish its objectives, the plan provides for the creation of several new committees and working groups, a research institute, and fisheries financing. These include:

- 1) An advisory committee on conservation and management of living marine resources,
- 2) A working group within the Italian Census Bureau (ISTAT) to collect and to compile fishery statistics,
- 3) A committee to coordinate scientific

research and the transfer of modern technology to the Italian marine fishing industry and to determine projects suitable for government financing,

4) A central institute of fisheries research and technology to be established with a grant of \$1.2 million and a still undetermined annual operating budget, and

5) Government financing of and subsidies to the fishing industry.

### Central Fund

A central fund is to be created to provide low interest loans and/or outright grants for: Construction of new fishing vessels (but only if balanced off by grounding of obsolete craft); construction of fish factory vessels; modernization of existing vessels; development or expansion of aquaculture projects; development or expansion of shore facilities for processing, storage, conservation, and marketing of local and EC-imported fishery products; acquisition of containers and transport vehicles; construction or expansion of retail outlets for local fishery products operated by Italian fishing associations, consortia, and cooperatives; operating capital (up to 15 percent) to owners of ocean-going fishing vessels and for joint ventures between Italian and foreign fishing companies (or foreign government fishery agencies) operating in waters under the jurisdiction of the foreign country concerned.

The loan interest rate is to be 40 percent (30 percent for companies located in southern Italy) of the reference rate determined by the Italian Ministry of the Treasury. (In practice, this comes to an interest rate of around 8 percent.) The loan cannot exceed 70 percent of the costs, but, in the case of fishing cooperatives and consortia, 80 percent

coverage of investment costs is allowed. The companies will also be able to request nonreimbursable grants for the same type of projects for an amount of up to 40 percent of the total cost; 50 percent with the concurrence of other local government entities; and 75 percent for initiatives undertaken by firms located in southern Italy. Grants may be obtained along with the subsidized loans. Another provision of the plan provides grants for the voluntary sinking of outdated fishing vessels at a rate of 400,000 Lire<sup>1</sup> per gross registered ton if no new vessel is built within 5 years and 200,000 Lire per gross ton if a new vessel is built in its place.

### Financing Needed

The plan is considered ambitious and well conceived, but seriously under-financed. It takes into account the fact that the Italian fishing fleet of 4,000 vessels — over half of which are outdated — should be halved to 2,000 modern, well-equipped vessels. However, the plan provides no incentives for new construction, and it is believed that most vessel owners will find the incentives to scuttle old vessels insufficient. Prominent Italian fishermen also doubt that the incentives to encourage the formation of consortia and cooperatives will be effective in the highly individualistic Italian fishing industry.

It has been noted that the Meridional Pesca<sup>2</sup> company which has arranged a joint venture with Fass Brothers of Hampton, Va., to catch and process squid in the U.S. 200-mile Fishery Conservation Zone during the summer of 1982 will be among the first to petition for government assistance under the plan's provision for grants and/or easy credit to Italian firms engaged in joint ventures with foreign governments or foreign companies. Since most of the African countries where Italy now fishes do not offer attractive prospects for joint ventures with Italian firms, such opportunities are more likely to develop with

Note: Unless otherwise credited, material in this section is from either the Foreign Fishery Information Releases (FFIR) compiled by Sune C. Sonu, Foreign Reporting Branch, Fishery Development Division, Southwest Region, National Marine Fisheries Service, NOAA, Terminal Island, CA 90731, or the International Fishery Releases (IFR), Language Services Bi-weekly (LSB) reports, or Language Services News Briefs (LSNB) produced by the Office of International Fisheries Affairs, National Marine Fisheries Service, NOAA, Washington, DC 20235.

<sup>1</sup>US\$1.00 = 1,382 Lire as of 17 June, 1982.

<sup>2</sup>Mention of trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

"stable" fishing partners in the United States and perhaps Canada. A joint venture with a Yugoslavian company is also in preparation.

### Squid Allocations

The new EC-Canadian fisheries agreement permitted EC countries to catch as much as 7,000 metric tons (t) of squid in Canadian waters last summer. Since Italy, except for France and West Germany, is the only EC country interested in fishing Canadian-claimed waters, Italy hoped for a large share of that amount. Since the EC was behind schedule in making a breakdown of the Canadian fishery allocations to the EC countries, Italy was reportedly close to unilaterally declaring that it intended to take for itself 4,000 t and thus force an EC decision.

By May, the United States had not yet announced the fishing allocations for the summer 1982 season. As the U.S. fishing season began on 15 June, the Italian fleet was desperately awaiting word about its U.S. allocations to ready its fishing fleet. The Italians have complained that every year the U.S. announcement comes so late that the season is already partly over and Italy cannot catch its full allocations in time.

The new Canadian agreement has not decreased the Italian interest in fishing U.S. waters for squid. Italian long-finned (*Loligo*) and short-finned (*Illex*) squid consumption is about 30,000 t a year. The Italian fleet currently provides less than one-third of that amount; the rest is imported (mainly from Argentina where squid is fished by Polish fishermen).

The 800-tons of short and long-finned squid allocated to the Meridionale-Fass joint venture will be deducted from the total U.S. squid allocation to Italy, which could leave the rest of the Italian fleet with an amount too small to make its squid operations profitable. Italian fishermen now hope that Italian efforts to launch joint ventures with U.S. companies (and to provide gear and freezing technology) will be recognized when U.S. allocations are made. Italian companies are watching the results of the Meridionale-Fass project

and plan two more joint ventures with U.S. companies in the Boston area in the near future. (Source: IFR-82/85.)

## Mexican State Fish Company Tells Plans

Mexico's state fishing company, Productos Pesqueros Mexicanos (PPM), is the largest fishing company in Latin America. As a result of the government's emphasis on fisheries development, PPM has sharply expanded its fleet and production. PPM plans to process 260,000 metric tons (t) of fish for human consumption in 1982, 160 percent more than the 100,000 t processed in 1981.

PPM General Manager, Jose Bellot Castro, has set a primary goal of giving more autonomy to individual plant managers so operations can be better adjusted to local conditions. PPM also plans to study the possibilities of establishing regional divisions. PPM affiliates in Baja California and Sonora are already operating with considerable autonomy as Industrias Pesqueras Paraestatales del Noroeste.

The 1982 goals for the PPM fleet included finishing the construction of most of the 165 new fishing vessels being built for PPM, overhauling the fleet and establishing a preventive maintenance schedule, and establishing production goals for each vessel.

Processing plant goals for 1982 included opening the new plants at Lerman in Campeche and Topolobampo in Sinaloa. The Topolobampo plant will be the largest in Mexico and perhaps the largest in Latin America. They also planned to open the smaller plants PPM was building in association with private investors and cooperatives and install fish processing lines in the shrimp plants purchased from private owners<sup>1</sup>. Likewise, all of PPM's plants were to be incorporated

<sup>1</sup>PPM acquired almost all of Mexico's privately-owned shrimp packing plants in late 1981 and early 1982. The acquisition was part of a larger government plan to restructure the country's shrimp industry. At the same time, privately owned vessels were transferred to the cooperatives.

into the Pepepez and Pescador programs which are designed to increase the edible fishery products available to Mexican consumers.

Another PPM priority during 1982 was to improve Mexico's marketing system, especially for tuna, sardines, and shrimp. Tuna is a special priority for PPM because of the rapidly expanding catch<sup>2</sup> by Mexico's growing tuna fleet. Most of the catch has been canned, but Mexican companies have been unable to export successfully much of the canned product. As a result, PPM is trying to promote massive increases in domestic consumption.

Sardines are important to PPM because their catch is also increasing and because sardines are an important element of the Sistema Mexicano Alimentario (SAM), a government program to increase the food products available to low-income consumers.

Shrimp is also receiving special attention and PPM hopes to market more domestically. Traditionally, about 80 percent of Mexico's shrimp catch is exported to the United States. PPM officials, however, were not satisfied with the prices they received in the U.S. market during 1980 and 1981. Some PPM officials reportedly believe that developing the domestic market will help reduce the dependence on the U.S. market. The February 1982 floating of the Mexican peso sharply increased the value of the U.S. dollar in pesos and, as a result, the potential returns from shrimp exports in terms of U.S. dollars may make it difficult for PPM to divert shrimp from export markets to the domestic market.

Bellot also indicated that PPM plans to promote the marketing of squid. While not as important as tuna, sardines, and shrimp, Mexican fishermen have recently developed a new fishery for giant squid in the Gulf of California. PPM plans to promote exports as well as the marketing of frozen and cured fishery products in the domestic market. (Source: IFR 82/70.)

<sup>2</sup>See "The expansion of the Mexican tuna fleet, 1981-1984," Mar. Fish. Rev. 44(8): 25-29.

## Latin American Fishery Officials Listed

The NMFS Division of Foreign Fisheries Analysis, which regularly monitors worldwide fishery developments, has prepared the following list

of the names and addresses of fishery officials in almost 40 Latin American countries. Any readers who have updated names or addresses for these of-

ficials are requested to send that information to the Division (F/1A-1), NMFS, NOAA, Washington, D.C. 20235.

### *Antigua*

C. Camacho  
Fisheries Advisor  
Ministry of Agriculture and Supply  
Long Street  
St. Johns, Antigua

### *Argentina*

Subsecretario  
Subsecretaria de Pesca  
San Martin 459, Piso 2  
Buenos Aires, Argentina  
Telephone: 44-6879

### *Bahamas*

Ronald W. Thompson  
Director of Fisheries  
P.O. Box N 3028  
Nassau, Bahamas  
Telephone: 809-322-1277

### *Barbados*

Robert Hastings  
Ministry of Agriculture, Food,  
and Consumer Affairs  
Codrington, St. Michael  
Barbados

### *Belize*

George Winston Miller  
Fisheries Administrator  
Fisheries Unit  
Ministry of Trade and Industries  
P.O. Box 148  
Belize City, Belize  
Telephone: 02-4552, 4708

### *Bermuda*

Dr. James B. Herkes  
Director of Agriculture and  
Fisheries  
P.O. Box 834  
Hamilton 5, Bermuda

### *Bolivia*

Departamento de Vida Silvestre,  
y Pesca Parques Nacionales, Caza  
Casilla 936  
La Paz, Bolivia

### *Brazil*

Dr. Roberto Ferreira do Amaral  
Superintendent  
Superintendencia do Desenvolvi-  
mento da Pesca (SUDEPE)  
Avenida W-3 Norte  
Quadra 506, Bloco C. Lote 7  
Brazil

### *British Virgin Islands*

Ministry of Communications,  
Works, and Industry  
Roadtown, Tortola  
British Virgin Islands

### *Chile*

Roberto Verdugo Gormaz  
Subsecretario de Pesca  
Ministerio de Economia  
Teatinos 120, Piso 11, Oficina 43  
Santiago, Chile

### *Colombia*

Dr. Gabriel Acevedo  
Subgerencia de Fomento de  
Pesca y Fauna Terrestre  
Instituto de Recursos Naturales  
Renovables (INDERENA)  
Ministerio de Agricultura  
Calle 26 No. 13-B-47,  
Bogota, Colombia

### *Costa Rica*

Ing. Eduardo Bravo, Director  
Departamento de Flora y Fauna  
Ministerio de Agricultura y  
Ganaderia  
Apartado 11094  
Costa Rica, San Jose

### *Cuba*

Jorge A. Fernandez Cuervo-Vinent  
Ministerio de la Industria Pesquera  
Apartado Postal 605  
La Habana 1, Cuba

### *Dominica*

Heskeith Alexander  
Ministry of Agriculture, Land, Forestry,  
Fisheries, and Cooperatives  
Government Headquarters  
Kennedy Avenue  
Roseau, Dominica  
Telephone: 2401 Ext. 285

### *Dominican Republic*

Cpt. Narciso Almante  
Direccion General de Recursos  
Pesqueros  
Secretaria de Estado de Agricultura  
Centro de los Heroes  
Santo Domingo, Dominican Republic

### *Ecuador*

Tully Looor  
Subsecretaria de Pesca  
Ministerio de Recursos Naturales  
y Energeticos  
Street address unknown  
Guayaquil, Ecuador

### *El Salvador*

Lic. Napoleon Salamanca  
Director General  
Directorio General de Desarrollo  
Industrial y Control  
Ministerio de Economia  
4A Avenida Norte No. 210  
San Salvador, El Salvador  
Telephone: 21-1884

### *Grenada*

James Finlay  
Ministry of Agro-Industry  
Belmont, St. Georges  
Fisheries Officer  
Grenada

### *Guatemala*

Luis Fernando Martinez  
Director of Fisheries  
Division de Fauna, Pesca y Acuicultura  
Direccion General de Recursos  
Naturales Renovables  
Avenida del Observatorio, Zona 13  
Ciudad de Guatemala, Guatemala

### *French Guiana*

Gerard Paulmier  
Institute Scientifique et Tech-  
nique des Peches Maritimes  
Laboratoire de Cayenne  
Cayenne, French Guiana

### *Guadeloupe*

No information

### *Guyana*

Rueben Charles  
Chief Fisheries Officer  
39 Brickdam  
Georgetown, Guyana  
Telephone: 61833

### *Haiti*

Emmanuel Garnier  
Directeur de Service de Pecheries  
Departement de l'Agriculture  
47 Ave. Marie Jeanne  
Damien, Port-au-Prince  
Haiti

### *Honduras*

Lic. Humberto Caballero  
Director-General de Recursos  
Naturales Renovables  
Edificio Talavera  
8 Ave., 11-12 Calle  
Comayagua, D.C., Honduras

### *Jamaica*

Eustace A. Royer  
Director of Fisheries  
Fisheries Division  
Ministry of Agriculture  
Marcus Garvey Dr.  
P.O. Box 470  
Kingston 6, Jamaica

### *Martinique*

Mr. Jeffrey  
Affaires Maritimes  
Boulevard Chevelier  
St. Marthe  
97200 Ft. de France  
Martinique

**Mexico**  
Lic. Fernando Rafful Miguel  
Secretaria de Pesca  
Alvaro Obregon 269  
Mexico, D.F., Mexico

**Montserrat**  
Ministry of Agriculture, Trade,  
Lands, and Housing  
Address not available

**Netherlands Antilles**  
Geraard van Buurt  
Fisheries Section Head  
Department of Agriculture  
and Fisheries  
Klein Kwartier 33  
Curacao, Netherlands Antilles

**Nicaragua**  
Alfredo Aoniz  
Instituto Nicaraguense de  
la Pesca  
Apartado 2020  
Managua, Nicaragua

**Panama**  
Luis Rodriguez  
Directorio General de  
Recursos Marinos  
P.O. Box 3318  
Panama 4, Panama

**Paraguay**  
Seccion de Pesca  
Ministerio de Agricultura  
Pte. Franco y 14 de Mayo  
Asuncion, Paraguay

**Peru**  
Rene Deustua  
Ministro de Pesqueria  
Javier Prado Este 2465  
Lima 30, Peru

**Puerto Rico**  
Inoel Rivera  
CODREMAR  
Department of Natural Resources  
San Juan, Puerto Rico 00903

**St. Christopher-Nevis-Anguilla**  
Ministry of Agriculture, Lands,  
Housing, Labor, Trade,  
Industry, and Development  
Government Headquarters  
P.O. Box 186  
Basseterre, St. Kitts

**St. Lucia**  
H. D. Walters  
Fisheries Officer  
Ministry of Agriculture, Lands,  
Fisheries, and Labor  
and Cooperatives  
Castries, St. Lucia

**St. Vincent**  
No information

**Suriname**  
F. Vreden  
Minister of Agriculture, Fish-  
eries and Forestry  
Cultuurtoelaan  
Paramaribo, Suriname

**Trinidad and Tobago**  
Hugh E. Wood  
Senior Fisheries Officer  
Fisheries Division  
Ministry of Agriculture,  
Lands and Fisheries  
St. Clair Circle  
Port of Spain, Trinidad  
Telephone: 25715

**Turks and Caicos**  
No information

**Uruguay**  
Cpt. (C/N) U. Walter Perez

**Director**  
Instituto Nacional de Pesca (INAPE)  
Ministerio de Agricultura y Pesca  
Constituyente 1476  
Montevideo, Uruguay

**Venezuela**  
Lic. Carlos E. Gimenez  
Director  
Direccion General de Desar-  
rollo Pesquero  
Ministerio de Agricultura y Cria  
Torre Norte, Piso 9  
Centro Simon Bolivar  
Caracas, Venezuela

## Mexican Shrimp Fleet Transferred to Coops

The Mexican government has begun to fulfill a promise made to fishermen's cooperatives in the 1930's. The government is financing the purchase of all the country's privately-owned shrimp trawlers by the cooperatives and the purchase of shrimp processing plants by the state-owned company, Productos Pesqueros Mexicanos. The vessel purchases are being financed by the Banco Nacional Pesquero y Portuario (Banpesca).

Pacific coast trawlers were transferred in October and November of 1981. Gulf of Mexico trawlers were to be transferred in February 1982, but disputes between the owners and the cooperatives over prices delayed the transfer. Unlike the Pacific coast cooperatives, few Gulf of Mexico cooperatives own their own trawlers. As a result of the delay, many vessels were tied up in port during January, February, and March 1982. Reports

from Mexico indicated that as of early April about 90 percent of the vessels had been transferred to and deployed by the cooperatives. The impasse has significantly affected 1982 Mexican shrimp exports to the United States.

A "productivity program" involved in the transfer stipulates that certain amounts of finfish must also be fished by the shrimp trawlers. Also, the shrimp by-catch will have to be taken to port. A logbook system is to be instituted to help define fishing areas and resources available, according to the Mexican Secretariat of Fisheries.

The Secretariat has prepared a 5-page report on the transfer of the vessels, detailing the procedures for appraising and transferring the vessels, the government's role, and how the cooperatives will pay back the government. A copy can be obtained by requesting "Mexican Shrimp Fleet" (IFR-82/51) from local NMFS Statistics and Market News Offices, enclosing a large self-addressed envelope with \$0.37 postage.

## Japan Expects Record Fall Chum Salmon Catch

Japan's 1982 fall chum salmon catch off Hokkaido will be a record high, according to a forecast made by the Japan Fishery Agency's Hokkaido Salmon Hatchery. The announced forecast is shown below by area in comparison with 1981 actual catches. (Source: FFIR 82-14.)

Japan's 1982 fall chum salmon catch forecast.

Area	Catch (1,000 fish)		1982/1981 Comparison (%)
	1982 Forecast	1981 Actual catch	
Okhotsk Sea	5,991.8	5,774.2	104
Japan Sea	1,303.8	1,112.0	117
Pacific Ocean			
Nemuro area	5,874.7	5,761.4	102
E. of Cape Erimo	5,678.1	5,759.2	99
W. of Cape Erimo	4,151.9	3,519.2	118
Total	23,000.3	21,926.0	105

## Northwest and Alaska Fisheries Center Technical Memoranda

In addition to its formal scientific publications, the National Marine Fisheries Service uses the NOAA Technical Memorandum series for informal publications of specialized reports that require multiple copies, but when complete formal review and editorial processing are not appropriate or feasible. However, documents in this series reflect sound professional work and are referenced in formal journals.

This month, the first 29 Technical Memoranda produced by the NMFS Northwest and Alaska Fisheries Center, Seattle, Wash., are listed. Copies may be ordered by number from the National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161.

**"Annotated bibliography of interspecific hybridization of fishes of the subfamily Salmonidae,"** by James R. Dangel, Paul T. Macy, and Fred C. Withler. U.S. Dep. Commer., NOAA Tech. Memo. NMFS NWFC-1, 48 p., 1973.

**"Food of the Pacific white-sided dolphin, *Lagenorhynchus obliquidens*, Dall's porpoise, *Phocoenoides dalli*, and northern fur seal, *Callorhinus ursinus*, off California and Washington; with appendices on size and food of Dall's porpoise from Alaskan waters,"** by Hiroshi Kajimura, Clifford H. Fiscus, and Richard K. Stroud. U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-2, 30 p., 1980. (NTIS number is PB80 223274.)

**"Summary of northern fur seal data and collection procedures, Volume 1: Land data of the United States and Soviet Union (excluding tag and recovery records),"** Robert H. Lander (editor). U.S. Dep. Commer., NOAA Tech.

Memo NMFS F/NWC-3, 315 p., 1980. (NTIS number is PB81 106502.)

**"Summary of northern fur seal data and collection procedures, Volume 2: Eastern Pacific pelagic data of the United States and Canada (excluding fur seals sighted),"** Robert H. Lander (editor). U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-4, 541 p., 1980. (NTIS number is PB81 123413.)

**"Summary of northern fur seal data and collection procedures, Volume 3: Western Pacific pelagic data of the Soviet Union and Japan, 1958-1978 (excluding fur seals sighted),"** Robert H. Lander and Hiroshi Kajimura (editors). U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-5, 304 p., 1980. (NTIS number is PB81 165904.)

**"Releases of anadromous salmon and trout from U.S. and Canadian Pacific coast rearing facilities, 1960-1976,"** by Robert Z. Smith and Roy J. Wahle. U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-6, 411 p., 1981. (NTIS number is PB82 196452.)

**"Changes in relative abundance and size composition of sablefish in the coastal waters of southeast Alaska, 1978-80,"** by Harold H. Zenger and Steven E. Hughes. U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-7, 27 p., 1981. (NTIS number is PB81 181935.)

**"Changes in relative abundance and size composition of sablefish in the coastal waters of Washington and Oregon, 1979-80,"** by Norman B. Parks and Steven E. Hughes. U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-8, 25 p., 1981. (NTIS number is PB82 202368.)

**"Economic impacts of the Alaska**

**shellfish fishery: An input-output analysis,"** by Walter Butcher, Joanne Buteau, Kenneth Hassenmiller, Glenn Petry, and Samih Staitieh. U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-9, 103 p., 1981. (NTIS number is PB82 169723.)

**"Gulf of Alaska bottomfish and shellfish resources,"** by Miles S. Alton. U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-10, 51 p., 1981. (NTIS number is PB81 224347.)

**"A summary of foreign Pacific whiting catches and trawl positions in the Washington-California region, 1977-1980,"** by Kathleen D. Edwards, Thomas C. Dark, Robert French, Russell Nelson, Jr., and Janet Wall. U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-11, 206 p., 1981. (NTIS number is PB82 109554.)

**"Transplantation and homing experiments on salmon, *Oncorhynchus* spp., and steelhead trout, *Salmo gairdneri*, in the Columbia River system: Fish of the 1939-44 broods,"** by Leonard A. Fulton and Roger E. Pearson. U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-12, 97 p., 1981. (NTIS number is PB82 124314.)

**"Trawl survey of groundfish resources in the Gulf of Alaska, summer 1978,"** by Gene C. Feldman and Craig S. Rose. U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-13, 44 p., 1981. (NTIS number is PB82 124504.)

**"All-nation removals of groundfish, herring, and shrimp from the eastern Bering Sea and northeast Pacific Ocean, 1964-1980,"** by Sueto Murai, Harold A. Gangmark, and Robert R. French. U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-14, 40 p., 1981. (NTIS number is PB82 148693.)

**"Estimation of a decreasing population size over time,"** by Russell F. Kappenman. U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-15, 7 p., 1981. (NTIS number is PB82 161191.)

**"Factors affecting bottom trawl behavior: Results of experiments with 83/112 Eastern trawls towed from the NOAA ship *Miller Freeman*,"** by Charles William West. U.S. Dep.

Commer., NOAA Tech. Memo. NMFS F/NWC-16, 36 p., 1981. (NTIS number is PB82 150400.)

"Census of northern sea lion (*Eumetopias jubatus*) in central Aleutian Islands, Alaska, 17 June-15 July 1979, with notes on other marine mammals and birds," by Clifford H. Fiscus, David J. Rugh, and Thomas R. Loughlin. U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-17, 109 p., 1981. (NTIS number is PB82 146218.)

"A description of the resource database system of the Northwest and Alaska Fisheries Center, 1981," by Ralph J. Mintel and Gary B. Smith. U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-18, 111 p., 1981. (NTIS number is PB82 161159.)

"A numerical simulation model of the population dynamics of walleye pollock, *Theragra chalcogramma* (Pallas 1811), in a simplified ecosystem: Part 1, model description," by Charles D. Knechtel and Lewis J. Bledsoe. U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-19, 212 p., 1981. (NTIS number is PB82 163049.)

"Relative abundance and size composition of sablefish in coastal waters of southeast Alaska, 1978-81," by Harold H. Zenger, Jr. U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-20, 42 p., 1981. (NTIS number is PB82 174566.)

"Bowhead whale radio tagging feasibility study and review of large cetacean tagging," by Larry J. Hobbs and Michael E. Goebel. U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-21, 68 p., 1982. (NTIS number is PB82 193145.)

"Differences in susceptibility among three stocks of chinook salmon, *Oncorhynchus tshawytscha*, to two isolates of infectious hematopoietic necrosis virus," by Alex C. Wertheimer and James R. Winton. U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-22, 10 p., 1982.

"Trawl survey of groundfish resources off the Aleutian Islands, July-August 1980," by Lael L. Ronholt, Franklin R. Shaw, and Thomas K. Wilderbuhr. U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-23, 84 p. (NTIS number is PB82

189986.)

"Cohort analysis of catch data on Pacific herring in the eastern Bering Sea, 1959-81," by Vidar G. Weststad. U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-24, 18 p., 1982. (NTIS number is PB82 193947.)

"Current abundance of Pacific cod (*Gadus macrocephalus*) in the eastern Bering Sea and expected abundance in 1982-86," by Vidar Weststad, Richard Bakkala, and Jeffrey June. U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-25, 26 p., 1982.

"Changes in relative abundance and size composition of sablefish in coastal waters of Washington and Oregon, 1979-81," by Norman B. Parks. U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-26, 28 p., 1982.

"Fluctuations of fish stocks and the consequences of the fluctuations to fishery and its management," by Taivo Laevastu and Richard Marasco. U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-27, 53 p., 1982.

"Squids taken in surface gillnets in the north Pacific Ocean by the Pacific salmon investigations program, 1955-72," by Clifford H. Fiscus and Roger W. Mercer. U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-28, 32 p., 1982.

"Data on fish species from Bering Sea and Gulf of Alaska," by Karl Niggol. U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-29, 125 p., 1982.

## International Shrimp Workshop Proceedings

The second issue of the *Kuwait Bulletin of Marine Science*, edited by A. S. D. Farmer, has been devoted to the "Proceedings of the International Shrimp Releasing, Marking, and Recruitment Workshop" held 25-29 November 1978 in Salmiya, Kuwait. The Bulletin is published by the Kuwait Institute for Scientific Research in Salmiya.

Seeing declining shrimp stocks and catches, the Institute established its

Shrimp Culture Project to develop hatchery techniques suitable for use in Kuwait which would permit the mass releasing of juvenile shrimp into the sea similar to Japan's stocking of shrimp into the Seto Inland Sea. With appropriate techniques developed, they initiated the workshop to address the questions of the efficacy of the mass releasing of shrimps into the sea, whether releasing shrimps is beneficial, optimum releasing numbers, and whether the shrimp culture project should be directed toward commercial culture to marketable size.

The result is an impressive volume divided into five sessions, with the first providing a historical review of the Kuwait Shrimp Culture Project and a bibliography on the releasing, recruitment, mortality and marking of penaeid shrimps by A. S. D. Farmer. Observations on the biology of *Penaeus semisulcatus* in Kuwait are made by K. H. Mohamed, M. El-Musa, and A.-R. Abdul-Ghaffar while Farmer and M. H. Al-Attar report results of shrimp marking programs in Kuwait. The development of the Kuwait shrimp fishery and its present status are presented by N. P. van Zalinge, and M. El-Musa and A.-R. Abdul-Ghaffar.

Session II, Shrimp Releasing, contains H. Kurata's review of shrimp fry releasing techniques in Japan (with special reference to artificial tideland) and a report on large-scale production of shrimp for releasing in Japan and the United States and the results of the releasing program at Panama City, Fla., by J. Kittaka.

Session III, Shrimp Tagging, provides reviews of crustacean marking methods (Farmer), the NMFS shrimp research program in the Gulf of Mexico (E. F. Klima), shrimp marking trials in Japan (K. Ishioka), mark-recapture and recruitment studies on Australian penaeid shrimp (J. W. Penn), mathematical models for use with mark-recapture studies (R. Jones), and a design for a simplified releasing cage for marked shrimp or fish (Farmer and Al-Attar).

Session IV, Shrimp Fisheries Management, includes papers on estimates of mortality rate and population size

for shrimp in Kuwait waters (Jones and N. P. van Zalinge), population dynamics and management of the shrimp fishery in the Seto Inland Sea (T. Doi), prediction of shrimp landings from investigations on the abundance of post-larval shrimp (J. Y. Christmas and T. N. Van Devender), factors affecting shrimp recruitment (F. Sander), and a review of the North American penaeid fisheries, with particular reference to Mexico (C. P. Mathews).

A short concluding session presents the workshop group's statement of findings and recommendations. Group discussions following each paper are also published following each paper.

Further information on the availability of the report can be obtained from the Mariculture and Fisheries Department, Kuwait Institute for Scientific Research, P.O. Box 1638, Salmiya, State of Kuwait. Paper-bound, 415 pages, the publication is very well edited and produced and will likely be of interest to many shrimp researchers and managers.

## **A Zooplankton Atlas of the SW Atlantic Ocean**

The "Atlas of the Zooplankton of the Southwestern Atlantic and Methods in Marine Zooplankton Research," edited by Demetrio Boltovskoy, has been published as a Special Publication by INIDEP, the Instituto Nacional de Investigacion y Desarrollo Pesquero, Casilla de Correo 175, Playa Grande, 7600 Mar del Plata, Argentina. Cost of the 939 page paper-bound volume is \$40.00.

Entirely in Spanish, the contents are arranged in three parts: Research methods, physical and biological features of the southwestern Atlantic, and zooplankton of the southwestern Atlantic. Part I includes material on sample collection (nets; automatic, continuous, and high-speed samplers; pump sampling; bottle sampling; miscellaneous methods; and industrial-scale collection. Other problems described include sampler efficiency and handling, shape of sampler, the gauze, avoidance of samplers (dodging), esti-

mation of water volume filtered, depth of tow, towing speed, and sampling design. Also discussed is sample treatment, marine zooplankton cultivation, and general handling of data, literature, and material.

Part II describes the physical features, water masses, and biological features of the southwestern Atlantic while Part III examines the region's zooplankton. Here, each chapter includes a brief account of the biology, reproduction, general distribution, importance and applications, trophic relationships, and methods of research of the particular group. Detailed information is given on the distribution in the southwestern Atlantic (0°-60°S and 70°-25°W), including critical analysis of the previous records of each species in the area of study. The last section of each chapter of Part III is devoted to the identification of the species known to occur in the region, including descriptions, keys, and illustrations of all the taxa. Included is data on radiolaria, foraminifera, tintinnina Siphonophorae, Hydromedusae, Polychaeta, Pteropoda, Cladocera, Ostracoda, Copepoda, Euphausiacea, Decapoda larvae, Chaetognatha, Thaliacea: Salpidae, Appendicularia, and Ichthyoplankton.

The volume contains about 3,000 bibliographic references and 270 figures with 80 plates with species illustrations. Sponsors, in addition to INIDEP, include Argentina's Consejo Nacional de Investigaciones Cientificas y Tecnicas and the Comision de Investigaciones Cientificas de la Provincia de Buenos Aires and UNESCO.

## **Tuna Processing Handbook Available**

The New Zealand Ministry of Agriculture and Fisheries has prepared a 36-page report entitled "A Handbook on Processing Southern Bluefin Tuna for the Fresh Chilled Sashimi Market in Japan." The report is composed of five sections. The introduction gives a brief background of the fishery — the Zealand-claimed waters. The main section explains processing techniques

and discusses problems which often arise. There are also sections dealing with proper handling and storage of fish in ice, freezing chilled fish, and packing large fish for export by air in accordance with International Air Transportation Association guidelines. The manual is the result of research carried out on Japanese longliners operating off New Zealand, research conducted at various sashimi markets in Japan, and the practical experience of New Zealand fishermen.

A copy of the report may be requested by title from Michael A. Carney, (F/IA-1), Division of Foreign Fisheries Analysis, NMFS, NOAA, Washington, DC 20235. Please enclose a 9" x 12" self-addressed envelope with \$0.80 postage.

## **Uruguayan Fisheries Report Available**

Uruguay has a small fishing industry, but the government's fisheries development program has been successful. The fisheries catch has increased from only 17,500 metric tons (t) in 1973 to about 120,000 t in 1980, or nearly 6 times. Government officials had projected a 1981 catch of 140,000 tons. Most of the catch is exported and the fishing industry is rapidly becoming an important source of foreign exchange earnings. Fishery exports exceeded \$50.0 million in 1981, of which \$15.5 million was shipped to the United States.

The National Marine Fisheries Service and the U.S. Embassy in Montevideo prepared a 19-page report entitled "The Fishing Industry of Uruguay, 1975," describing the country's fishing industry and fisheries development program in 1975 (DIB-77-08-040). The U.S. Embassy in Montevideo has prepared a 34-page update entitled "The Fishing Industry in Uruguay, 1980" (ITA-82-01-007). Either of the two reports can be ordered from the National Technical Information Service, U.S. Department of Commerce, Springfield, VA 22161. The 1975 report costs \$5.00 and the 1980 report costs \$6.50. (Source: IFR-82/32R.)

## Editorial Guidelines for Marine Fisheries Review

*Marine Fisheries Review* publishes review articles, original research reports, significant progress reports, technical notes, and news articles on fisheries science, engineering, and economics, commercial and recreational fisheries, marine mammal studies, aquaculture, and U.S. and foreign fisheries developments. Emphasis, however, is on in-depth review articles and practical or applied aspects of marine fisheries rather than pure research.

Preferred paper length ranges from 4 to 12 printed pages (about 10-40 manuscript pages), although shorter and longer papers are sometimes accepted. Papers are normally printed within 4-6 months of acceptance. Publication is hastened when manuscripts conform to the following recommended guidelines.

### The Manuscript

Submission of a manuscript to *Marine Fisheries Review* implies that the manuscript is the author's own work, has not been submitted for publication elsewhere, and is ready for publication as submitted. Commerce Department personnel should submit papers under completed NOAA Form 25-700.

Manuscripts must be typed (double-spaced) on high-quality white bond paper and submitted with two duplicate (but not carbon) copies. The complete manuscript normally includes a title page, a short abstract (if needed), text, literature citations, tables, figure legends, footnotes, and the figures. The title page should carry the title and the name, department, institution or other affiliation, and complete address (plus current address if different) of the author(s). Manuscript pages should be numbered and have 1½-inch margins on all sides. Running heads are not used. An "Acknowledgments" section, if needed, may be placed at the end of the text. Use of appendices is discouraged.

### Abstract and Headings

Keep titles, heading, subheadings, and the abstract short and clear. Abstracts should be short (one-half page or less) and

double-spaced. Paper titles should be no longer than 60 characters; a four- to five-word (40 to 45 characters) title is ideal. Use heads sparingly, if at all. Heads should contain only 2-5 words; do not stack heads of different sizes.

### Style

In style, *Marine Fisheries Review* follows the "U.S. Government Printing Office Style Manual." Fish names follow the American Fisheries Society's Special Publication No. 6, "A List of Common and Scientific Names of Fishes from the United States and Canada," third edition, 1970. The "Merriam-Webster Third New International Dictionary" is used as the authority for correct spelling and word division. Only journal titles and scientific names (genera and species) should be italicized (underscored). Dates should be written as 3 November 1976. In text, literature is cited as Lynn and Reid (1968) or as (Lynn and Reid, 1968). Common abbreviations and symbols such as mm, m, g, ml, mg, and °C (without periods) may be used with numerals. Measurements are preferred in metric units; other equivalent units (i.e., fathoms, °F) may also be listed in parentheses.

### Tables and Footnotes

Tables and footnotes should be typed separately and double-spaced. Tables should be numbered and referenced in text. Table headings and format should be consistent; do not use vertical rules.

### Literature Citations

Title the list of references "Literature Citations" and include only published works or those actually in press. Citations must contain the complete title of the work, inclusive pagination, full journal title, the year and month and volume and issue numbers of the publication. Unpublished reports or manuscripts and personal communications must be footnoted. Include the title, author, pagination of the manuscript or report, and the address where it is on file. For personal communications, list the name, affiliation, and address of the communicator.

Citations should be double-spaced and listed alphabetically by the senior author's surname and initials. Co-authors should be listed by initials and surname. Where two or more citations have the same author(s), list them chronologically; where both author and year match on two or more, use lower-case alphabet to distinguish them (1969a, 1969b, 1969c, etc.).

Authors must double-check all literature cited; they alone are responsible for its accuracy.

### Figures

All figures should be clearly identified with the author's name and figure number, if used. Figure legends should be brief and a copy may be taped to the back of the figure. Figures may or may not be numbered. Do not write on the back of photographs. Photographs should be black and white, 8 × 10 inches, sharply focused glossies of strong contrast. Potential cover photos are welcome but their return cannot be guaranteed. Magnification listed for photomicrographs must match the figure submitted (a scale bar may be preferred).

Line art should be drawn with black India ink on white paper. Design, symbols, and lettering should be neat, legible, and simple. Avoid freehand lettering and heavy lettering and shading that could fill in when the figure is reduced. Consider column and page sizes when designing figures.

### Finally

First-rate, professional papers are neat, accurate, and complete. Authors should proofread the manuscript for typographical errors and double-check its contents and appearance before submission. Mail the manuscript flat, first-class mail, to: Editor, *Marine Fisheries Review*, Scientific Publications Office, National Marine Fisheries Service, NOAA, 7600 Sand Point Way N.E., BIN C15700, Seattle, WA 98115.

The senior author will receive 50 reprints (no cover) of his paper free of charge and 100 free copies are supplied to his organization. Cost estimates for additional reprints can be supplied upon request.

UNITED STATES  
DEPARTMENT OF COMMERCE

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION  
NATIONAL MARINE FISHERIES SERVICE  
SCIENTIFIC PUBLICATIONS OFFICE  
BIN C15700  
7600 SAND POINT WAY N.E.  
SEATTLE, WA 98115

OFFICIAL BUSINESS

POSTAGE AND FEES PAID  
U.S. DEPARTMENT OF COMMERCE  
COM-210

Second Class



\* MFR UNIVM300UFISSDUE008R 1  
\* UNIV MICROFILMS INTL  
\* SERIALS PROCESSING  
\* 300 N ZEEB RD  
\* ANN ARBOR MI 48106

